The Colorado Potato Beetle

Insects Injurious to Vegetables

By

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PREFACE

AMONG the hordes of insect foes with which the American farmer has to deal, those affecting vegetable crops are in many respects most troublesome. Vegetable plants are exceptionally perishable, and the control of their insect enemies entails a very considerable expenditure of money and time. The annual losses due to insect attack on vegetable crops is estimated at 20 per cent., or double that of the average farm crop. The injurious vegetable-feeding forms outnumber in species the insect enemies of any other single class of crops, excepting possibly deciduous fruits, and this nearly endless variety of pests necessitates information in regard to each. Many are intermittent in attack, hence the grower should be forewarned in order to guard against injury or to check it before irreparable damage has been accomplished. The progressive vegetable grower should be as amply equipped with knowledge as the fruit grower, and if he would be entirely successful in avoiding losses from insect ravages he should be provided with a complete outfit for spraying operations and should keep on hand or know where to obtain at short notice a good supply of necessary insecticides. The more general observance of certain farming methods with a view to the prevention of insect injury will greatly lessen the losses from this source. Until within recent years few farmers in planning the management of the farm for the season considered the effect which any given method of tillage would have upon injurious insects. Too frequently they fail to look far ahead, and as a rule rotation of crops where practiced is more for the sake of soil improvement than for the avoidance of insect injury, and yet crop rotation is the best and sometimes the only remedy for

certain species of insects. Among other general methods of farming strict cleanliness, including the destruction of weeds and burning over fields after harvest, fall plowing, crop rotation, the use of fertilizers, and the selection of the proper place and time for planting, must be considered. A knowledge of the classification of insects sufficient to enable the farmer to distinguish friends from foes is valuable, and finally comes a knowledge of what insecticides and repellents to use and the best means of preparing and applying them.

Accounts of most of our noxious species of insects have been published. These accounts, however, are distributed through government and state publications, reports of agricultural societies, magazines, and periodical publications of entomological societies, and even the daily press. As an example of the number of such publications on American economic entomology, the Bureau of Entomology, United States Department of Agriculture, has cited no less than 12,645 titles that had appeared to January 1, 1905, and the number of references to noxious insects is about 72,000. The average farmer has neither time nor opportunity to consult a tithe of these 12,000 odd works, and it is therefore the object of the following pages to collate concise accounts of the principal insects which affect one class of crops—vegetables. The order which will be followed is, as far as practicable, alphabetical, beginning with the insect enemies of asparagus, and ending with those which affect sweet potato, and finally miscellaneous or unclassified crops.

The insect enemies of vegetables have not hitherto been considered as a special topic in comprehensive form. Separate accounts, however, on the economic entomology of certain vegetables have been published, for example, of beets and of sweet potato.

In presenting this work to the public its author does not claim originality for its contents. It is, however, largely com-

piled from his own writings, although it has been found necessary to draw also from the works of others, and is based on an experience of about ten years with the subject with which it deals. The illustrations are in large part the same, or adaptations of, figures previously used in the Bureau of Entomology, United States Department of Agriculture, and are so credited.

F. H. CHITTENDEN.

United States Department of Agriculture,
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INTRODUCTION

VEGETABLES are subject to attack by insects from the time the seed is planted until the edible portion is ready for cooking. Insect injury manifests itself in different ways according to the plant attacked, the insect concerned, the stage of the insect, and the age and condition of the plant.

Manifestations of Insect Injury.—If plants soon after the seed has been sown fail to appear in due time, such failure is apt to be attributed to unfavorable atmospheric conditions or to imperfect seed, but examination will frequently show that some insect is at work. Among insects destructive to planted seed are wireworms and root-maggots, and in some cases insects that have fed on the seed stock while in store are planted with the seed, and this they destroy by eating out the germ. Familiar examples are the bean and pea weevils.

Fig. 1.—Asparagus tip, showing eggs and injury by asparagus beetles. (Author's illustration, U. S. Dept. Agr.)

Asparagus tips when ready for cutting are ruined for market by the asparagus beetles (see fig. 1). If plants like tomato that are reset are cut off abruptly near the ground, cutworms are nearly always at work. If the minute leaves of plants like cucumber, soon after beginning to sprout, are found eaten away, causing the plants to die, cucumber beetles are present. Corn is similarly affected by flea-beetles, as are also potato and other vegetables.

When stems or stalks of various plants are found with one or more holes of varying size, from that of a straw to considerably larger, this is evidence of a borer within, particularly

if excrement is exuding. Common species which do this injury are the common and corn stalk-borers and the grass-worm.

When plants like corn make unequal starts, a hill here and there showing greater thrift than elsewhere, injury is apt to be due to root-aphides. As a rule, these insects are accompanied by ants, which in most cases foster the "lice," and sometimes feed on the seeds.

When the leaves of plants are seen to be withering, and aphides or other sucking insects cannot be detected above ground, search will usually reveal the presence of white grubs, wireworms or other insects working below the surface, and the same is true of corn plants that fall after windstorms, root-worms also being present at such times. Another manifestation of the presence of root-worms is in the plants requiring too long a time for maturing, and producing sterile stalks, and, in the case of corn, yielding nubbins instead of complete ears. When young leaves are found with small round holes of about the size of a pea or a little smaller, leaf-beetles are usually present, while much smaller holes occurring in great profusion over leaves usually betoken the presence of flea-beetles. Extremely large and irregular holes in leaves of older growth are made by grasshoppers, crickets, and the larger caterpillars such as "woolly bears."

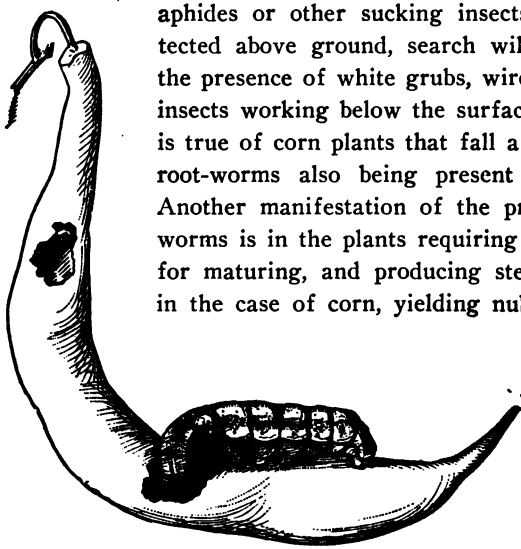

Fig. 2.—Bollworm entering bean pod. Somewhat enlarged (Author's illustration, U. S. Dept. Agr.)

Fruits such as melons are attacked by the melon worm and pickle worm; tomato, beans and corn by the bollworm, tomato

fruit worm or ear worm (fig. 2), and the edible roots of such plants as beet and carrot, are subject to injury by the carrot beetle, while potato tubers are damaged by the potato tuber worm. Seed pods and similar coverings of seeds are attacked by numerous insects, such as the corn ear worm, cucumber beetles, and others. Growing seeds are liable to be injured by some of the last mentioned insects as well as by some others which begin development when the seed approaches maturity. Familiar forms are the bean and pea weevils, and the Angoumois grain moth.

Many other forms of injury might be cited, but it may suffice to briefly mention the curling and dying down of leaves like melon, due to the presence of the melon aphis; the wilting and dying of squash caused by the severance of the stalks by the vine borer feeding within; the discoloration of leaves such as radish and their subsequent drying, owing to leaf-miner attack; and the destruction of whole plants of various kinds by army worms and migratory cutworms.

Every year that passes brings with it some new entomological problem to be solved, and this is especially true of insect injury to vegetables. The cause is usually a general or local outbreak of one or more serious pests, and the species concerned may be an old and well-known injurious form; it may be a comparatively unknown species or one that has not hitherto been identified with injury to useful plants; again the habits of the species may never have been studied owing to previous scarcity. It has perhaps lived in obscurity since time immemorial before any considerable outbreak attracts attention. It may be new to our country or even new to science.

Determination of the Injurious Insect.—The first problem that confronts the grower whose crops suffer from insect injury is the identification of the insect. Most insects have popular names, more or less local, which may be apt or may be rank misnomers, conveying no definite meaning.

Thus if a southern farmer complain of *"the* budworm," failing to state what plant is being injured, it is an impossibility to identify the insect concerned. The budworm of corn is the twelve-spotted cucumber beetle of the northern states, while the budworm of tobacco is the same as the tomato fruit worm and the corn ear worm or bollworm or a related species.

The first pest is *Diabrotica 12-punctata;* the second is

Fig. 3.—*Diabrotica 12-punctata.* (Riley, U. S. Dept. Agr.)

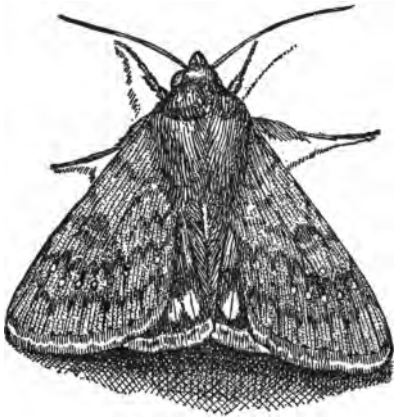

Fig. 4.—Bollworm moth in natural position. About twice natural size. (Quaintance, U. S. Dept. Agr.)

Heliothis obsoleta.[1] The parent of the first is a beetle (fig. 3) and of the latter a moth (fig. 4). It should be added that the first named species is also known as drill worm, while the latter is also called the shatter worm, this last name being shared also by the larger corn stalk-borer and perhaps by other species having the same habits, such as the fall army worm. The last is the grass-worm of the South and the fall army worm of the

[1] It is to be regretted that the scientific names are not more stable, but the bollworm was generally recognized under the name of *Heliothis,* until it was recently changed to *H. obsoleta.*

North. It is the "alfalfa worm" of Kansas and Nebraska and elsewhere it is simply called *the* army worm. Its technical name is *Laphygma frugiperda.*

It will thus be seen from the examples cited that the popular name of an insect has frequently little bearing on its identity. The scientific name must be determined.

A frequent source of injury to plants is due to contiguous growers who raise the same, or similar crops, for different purposes, *e. g.,* some may raise cucumbers for pickling, and in the immediate vicinity others grow melons for fruit, so that pickle-growers pick their crops while quite young, and the fruit-growers when older. This means that after the pickle-grower has stopped pickling, numerous vines remain, and the insects scatter from them to melon fields.

Spraying Potatoes in Western New York
[Photo by courtesy New York Experiment Station]

Insects Injurious to Vegetables

CHAPTER I

VALUE OF A KNOWLEDGE OF ENTOMOLOGY

GENERAL CONSIDERATIONS

For an intelligent understanding of the subject of insect control by agricultural practice one must know not alone that certain conditions produce an increase or decrease of certain forms of insects, but how this is accomplished, why the alternation of one crop with another is apt to result in insect injury, and why a system of crop rotation that would be of value in the control of one class of insects might be ineffective against another; how fall plowing, though destructive to one species, would not affect a different insect, and so on. In short, a knowledge of economic entomology beyond the fact that arsenicals are the proper remedies for mandibulate or chewing insects, and that kerosene will kill aphides or plant-lice, scale insects, and other soft-bodied insects, is a prerequisite to intelligent effort in the control of noxious insects. Before we can hope to avert losses we must know what our insect enemies are, what species are destroying each crop, which ones are responsible for primary injury, which are secondary or merely auxiliary, how injury is accomplished, when injury begins each year, when it ends, as well as other facts.

Similarly desirable is it to be able to recognize useful insects, such as ladybirds, syrphus flies, tachina and ichneumon flies and other parasites, that these may not be unnecessarily destroyed, but, if possible, encouraged in their useful work.

The different stages of some insects are so diverse that they can be identified only by specialists, and many entomologists are unable to recognize them without reference to technical descriptions and illustrations. Some knowledge of the distribution and origin of a species is of value, as well as some acquaintance with its history and literature.

A knowledge of the life history of an insect consists in knowing: when, where and how its eggs are deposited; how the larva feeds, and how many stages there are in this period; the habits of the larva, whether diurnal or nocturnal, whether omnivorous or a dainty feeder; how and where it transforms to pupa; how and where and in what stage it passes the winter; the number of generations produced each year; the first appearance of the insect and its disappearance, and the same of each generation; its food plants, natural and cultivated, and above all, its favorite foods, both as larva and adult. If to this we add a knowledge of the effect of farm practice and of insecticidal and mechanical methods on the insect we have, in a general manner, the main facts desired.

We must determine in what stage and at what time the insect is most vulnerable, and by practice and experiment learn the best remedy. A knowledge of the appearance and place of deposition of the eggs will, in the case of some species, furnish means for their control, for many insects can be combatted successfully merely by destroying the eggs. Others may be killed in their cocoons.

The most valuable weapon that can be used in combatting an insect consists in an intimate knowledge of the insect itself and its life economy, its natural enemies, its susceptibility to natural influences, heat and cold, dryness and moisture, and their effect upon its increase or decrease directly, or indirectly by destroying or favoring the growth of its enemies. A knowledge of the weeds and wild plants that furnish food for these insects, in addition to cultivated plants, and the soils in

which they attain their greatest development is also desirable. To this we must add a knowledge of the effects of different farm practices upon the insects, as well as of insecticides. There are many insects with which we cannot cope by the use of poisons, and it is only by a thorough knowledge of their life economy from the time the eggs are deposited until the perfect insect emerges, that we are able to mitigate losses from their ravages. The knowledge of some one or more facts apparently trivial in themselves may frequently enable us to prevent by farming methods injury which we cannot cure by means of poisons, mechanical or other direct methods

After seed has been selected with reference to its adaptability to the soil and climatic and other conditions one of the next problems that confront the grower is how to protect the crop from noxious insects and diseases. Fortunately we know approximately the life history and habits of a large proportion of the injurious insect inhabitants of this country, with the exception of some few species which have only been recently associated with injury, or which have lately been introduced from abroad.

As a necessary preliminary to the discussion of the insect enemies of the various vegetable crops, some idea of the structure and classification of insects must be given. It is pertinent to follow as a matter of course with general methods of control, which include (1) mechanical methods, (2) farm practice as preventives and (3) the preparation and means of applying poisons for the destruction of insects. Following this the different groups of insects which affect various crops and are not attached to single crops will be considered.

CLASSIFICATION OF INSECTS

If we would have an intelligent understanding of the causes that have led to the destruction of our crops, we must know something of the classification of insects and their nearest rel-

atives in order that we may be able to distinguish friends from foes and true insects from related forms. It is, of course, not essential that all of the Latin names which insects bear should be memorized, nor that anything approaching a complete classification be studied. The object of what is here presented on this topic is to assist in the ready identification by orders of such creatures as may come under observation as enemies or suspected enemies to plants under cultivation.

It is first desirable to eliminate animals which are not true insects but are related to them. These are all included (with true insects) under the branch Arthropoda of the Animal Kingdom and are distinguished by having their bodies composed of rings or segments more or less similar, joined together, most of them bearing jointed legs, the last character separating them from earthworms, eel-worms, or hair-worms, which have many segments but no legs. This branch is divided into four classes:

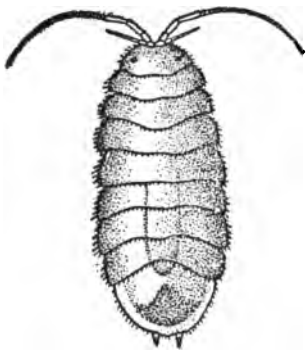

Fig. 5.—Water-cress sowbug (*Mancasellus brachyurus*). Enlarged. (After Richardson.)

Crustacea (*Crabs, lobsters, shrimps, crawfish, and sow-bugs* [*Oniscidæ*]).—Of this class only the sow-bugs or pill-bugs are apt to be confused with insects, and are of some economic importance, though not so injurious as many suppose. A common injurious species is shown in figure 5.

Arachnida (*Scorpions, daddy long-legs, spiders, mites, etc.*).—The scorpions are well known in the South and need no description. The same is true of the daddy long-legs or harvestmen, and spiders are everywhere. Among the mites, however, we have one species, the so-called red spider, which is quite injurious at times and which as it is commonly supposed to be an insect we will treat in one of the following chapters.

Myriopoda (*Thousand-legged worms*).—These creatures are known to most persons, and are divided into two orders: The Centipedes constitute a group in which each segment bears only a single pair of legs, while the body is generally flattened, and the antennæ are long with many joints. They live mostly by preying upon other insects. The Millipedes (fig. 6) have two

Fig. 6.—Myriopod. Enlarged

pairs of legs to each segment except the first three; the body is more or less cylindrical, and the antennæ are shorter with few joints. Most species feed upon decomposing vegetable matter, but some attack growing plants, more particularly those of the garden and greenhouse. Injury by these creatures, however, is frequently exaggerated, as in the case of the sow-bugs, previously mentioned.

Hexapoda (*Insects*).—This brings us to the true insects which are distinguished from the other three classes that have been mentioned by having the body divided into three distinct portions,—head, thorax (chest), and abdomen (belly) (fig. 7). They have a single pair of antennæ or feelers, normally three pairs of legs, and in the mature stage, one or two pairs of wings (save in exceptional cases). In our present advanced state of knowledge of the classification of true insects they have been divided into no less than nineteen[1] orders, but for present purposes what is known as the

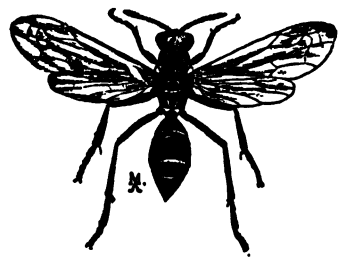

Fig. 7.—*Polistes bellicosus*. Somewhat enlarged. (Marx del, U. S. Dept. Agr.)

[1] For a list of these orders the reader is referred to pp. 77–81 of Comstock's Manual for the Study of Insects, Comstock Publishing Co., Ithaca, N. Y.

old Linnæan classification will suffice. This embraces seven orders,—Coleoptera, Orthoptera, Lepidoptera, Hymenoptera, Neuroptera, Diptera, and Hemiptera. The first six of these orders are mandibulate or *chewing* insects, at least in the most active stage of the insect, while the last are haustellate or *sucking* insects. This is important to know as on this classification depends the question as to whether stomach poisons, such as the arsenicals, or contact poisons, such as kerosene and its different preparations, are best suited for their destruction.

ORDERS OF INSECTS

Coleoptera or Beetles.—Beetles are distinguished by having a pair of more or less horny elytra or wing-covers which nor-

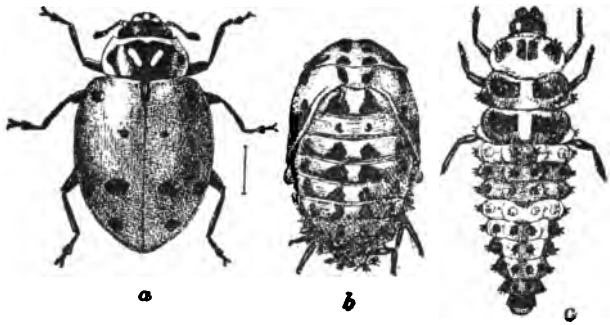

Fig. 8.—Convergent ladybird (*Hippodamia convergens*). *a* Adult; *b*, pupa, *c*, larva. All much enlarged. (Author's illustration. U. S. Dept. Agr.)

mally meet in a straight line down the back. Beneath them are the true membranous wings, usually folded. The mouth-parts of beetles and their larvæ (the latter usually called grubs) are formed for biting. A common beetle, a beneficial ladybird, is shown in figure 8, in different stages. Many species of beetles are injurious both in the adult and larval stages.

Among the best known forms of this order that injuriously

affect vegetables are wireworms, white grubs and their parents the May and June beetles, leaf-beetles, flea-beetles, pea and bean weevils, blister beetles, bill-bugs and other snout-beetles.

Lepidoptera (*Butterflies and moths*).—This order consists of insects having four membranous wings covered with more or less minute overlapping scales. The mouth-parts of the adults are formed for sucking, but the larvæ (called caterpillars, "worms," etc.) have well-developed chewing mouths. The Lepidoptera are of about equal importance with the Coleoptera or beetles as pests.

Fig. 9.—Cabbage looper (*Autographa brassicæ*). *a*, Male moth; *b*, egg; *c*, caterpillar; *d*, pupa in cocoon. *a*, *c*, *d*, One-third larger than natural; *b*, more enlarged. (*a*, *c*, *d*, after Howard; *b*, Chittenden, U. S. Dept. Agr.)

Examples of noxious forms that are destructive to vegetable crops are found in the cutworms, army worms, webworms, cabbage and tomato worms and various caterpillars. The cabbage looper is shown in figure 9 in its four principal stages.

Hymenoptera (*Sawflies, ants, wasps, bees, etc.*).—In this order there are two pairs of membranous wings with comparatively few veins, the hind-wings being the smaller pair. The mouth-parts of the adults are formed for both biting and sucking, and those of the larvæ, which are injurious, for biting. The females are furnished with stings, piercers or saws. In this order there are comparatively few noxious forms, and most of these are confined to the sawflies whose larvæ, known as slugs and false-worms, consume vegetation, doing injury similar

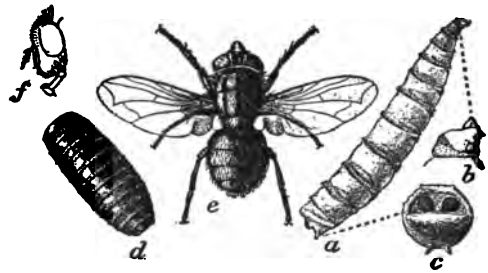

Fig. 10.—Screw-worm (*Compsomyia macellaria*). *a*, Maggot; *b*, head of same; *c*, anal segment from rear; *d*, puparium; *e*, adult fly; *f*, head from side. All enlarged.

to that accomplished by caterpillars. Some species of ants are troublesome, both directly and indirectly, in the latter case by acting as carriers of aphides or plant-lice, scales, and some other insects. This order, however, contains many beneficial forms, such as ichneumon and chalcis flies—parasites of noxious insects, and wasps which also destroy insect pests. One of these is shown in figure 7.

Diptera, or Flies.—Insects of this order have a single pair of wings which are borne on the mesothorax or middle portion of the thorax. The metathorax or hind portion bears a pair of knobbed thread-like processes called halteres, poisers, or balancers. The mouth-parts are formed for sucking in the adult condition, but in the larvæ (called maggots) the mouth-

parts are for biting. To the Diptera belong such pernicious insects as mosquitoes, house and horse flies, and root-maggots.

For illustrations of the Diptera, see figures 10 and 20.

Orthoptera (*Grasshoppers, crickets, roaches, katydids, etc.*). —In this order the insects have two pairs of wings,—the first somewhat horny and overlapping when at rest, the second pair thin and folded when at rest in plaits like a fan. The metamorphosis is incomplete, and all forms of the insect (except the egg) are active, with biting mouth-parts. The Rocky Mountain locust is an example of this order (figs. 11 and 12).

Hemiptera.—This order divides into three suborders,—the Heteroptera or true bugs, the Homoptera containing aphides, leafhoppers, etc., and the Physopoda or thrips. These groups have in common four wings, the mouth-parts in all stages formed for sucking, with incomplete metamorphoses.

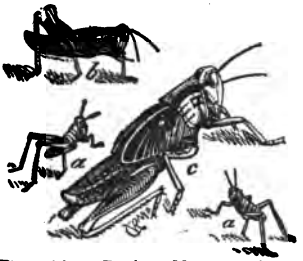

Fig. 11. — Rocky Mountain locust (*Melanoplus spretus*). *a*, *a*, Newly-hatched nymph; *b*, full-grown nymph; *c*, pupa, natural size. (After Riley.)

Fig. 12.—Rocky Mountain locust (*Melanoplus spretus*). Adult. Natural size. (After Riley.)

Suborder Heteroptera.—In the true bugs the anterior wings are thickened at the base and thinner at the extremities and overlap on the back, and the beak arises from the anterior portion of the head. It includes various forms of noxious insects, such as the chinch bug, numerous plant-bugs, (fig. 13), squash bug, and certain beneficial species, such as soldier-bugs.

Suborder Homoptera.—In this group the wings are of uniform thickness and usually slope at the sides of the body, the beak arising from the hinder portion of the lower side of the head. In this suborder most injurious pests are found in the aphides (fig. 14), leaf-hoppers and the like.

Suborder Physopoda.—The thrips have two pairs of wings of similar form—long, narrow, membranous, not folded, and

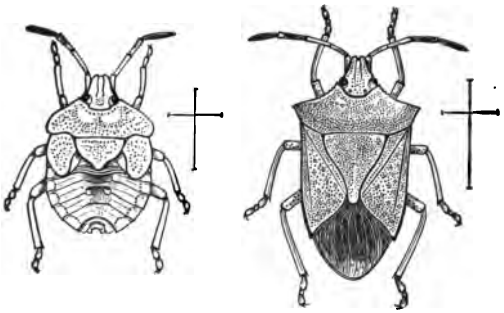

Fig. 13.—Brown plant-bug (*Euschistus variolarius*). Adult at right; last nymph stage at left. Enlarged. (Howard, U. S. Dept. Agr.)

with few or no veins. These are fringed with long hairs and do not fold, but are laid horizontally along the back when at rest[1] (fig. 15).

Neuroptera. — This order has been subdivided by recent writers into numerous other orders, but as they are of comparatively little if any economic importance, these

Fig. 14.—An aphis. Much enlarged

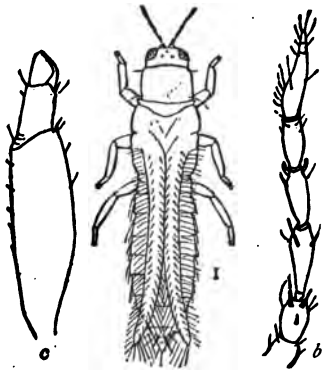

Fig. 15.—*Enthrips tritici*. *a*, Adult thrips; *b*, antenna; *c*, leg. All highly magnified. (After Hubbard, U. S. Dept. Agr.)

subdivisions need not be discussed here. The Neuroptera, in fact, have served as a "catch-all" for the groups that could not

[1] According to recent classification the Physopoda constitute a distinct order, but the Parasitica, which includes the parasites of man and other mammals, is a suborder of equal rank with the Heteroptera and Homoptera.

be classified with other orders. Among neuropteroid insects of interest to the farmer are the aphis lions or young of the lace-winged flies (fig. 16) which are beneficial by feeding on noxious insects and the dragon flies, which also do some good in destroying injurious forms.

Fig. 16.—A lace-wing with eggs at right

The Coleoptera, Lepidoptera, Hymenoptera, Neuroptera and Diptera have what is termed a *complete* metamorphosis, which means that they undergo four totally different stages, of egg, larva, pupa and adult or imago. In the remaining

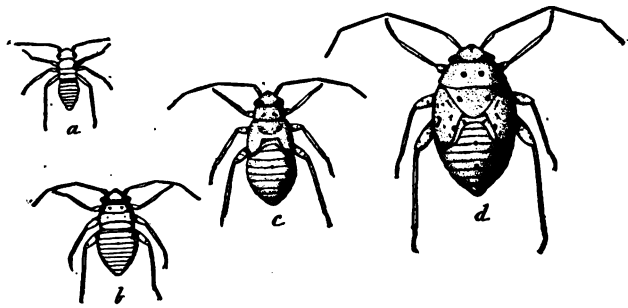

Fig. 17.—Tarnished plant-bug; four stages of nymphs. Enlarged (After Forbes)

two orders, Orthoptera and Hemiptera, the metamorphosis is *incomplete,* which means that in the stages between the egg and the imago the insect undergoes only a gradual change, each successive substage (nymph) after the first being very like the one that precedes or follows it (fig. 17).

NATURAL ELEMENTS IN THE CONTROL OF INSECTS

The benefits which the agriculturist reaps from the friendly assistance of various forms of insects which prey upon noxious forms is very considerable. Every tiller of the soil

should recognize their usefulness, but some are prone to expect too much from them in the subjugation of farm pests, and opinions are so diverse that the grower is sometimes in doubt as to whether the insects which are indicated as his allies are not, in reality, pests. A little study is necessary in many cases to discriminate between noxious and innoxious species and those which are truly and exclusively beneficial.

Organisms beneficial to agriculture may be variously classified, but fall naturally into four groups. The most important

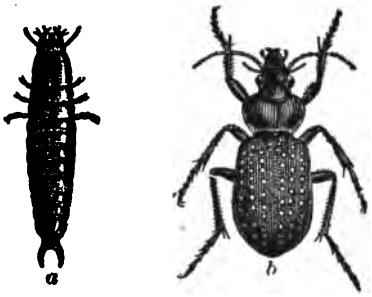

Fig. 18.—Fiery ground-beetle. *a*, Larva; *b*, beetle. (From Riley)

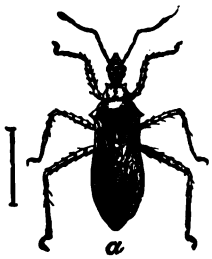

Fig. 19.—A soldier-bug (*Milyas cinctus*). (Riley, U. S. Dept. Agr.)

forms are: (1) predaceous insects, consisting of those which feed externally upon their prey; (2) predatory animals other than insects, such as birds and mammals; (3) parasitic insects which live in the bodies of their hosts; (4) fungi and diseases of bacterial origin.

The weather has quite as great effect in the control of insects as in the yield of the crops themselves. Extremes of heat or cold, excess of moisture or dryness have the same effect on insect as on plant life. The results of severe rainstorms, sudden cold snaps and prolonged drought on many insect pests are well known.

Of predaceous insects the most useful are undoubtedly the

ladybirds[1] (fig. 9), from their destruction of aphides alone, although some forms also do as good if not even better work in limiting the numbers of scale insects. Ladybirds also devour the eggs and larvæ of various other insects, and especially of soft-bodied forms. Several ground-beetles (fig. 18) live at the expense of cutworms and other vegetable-feeding caterpillars and the larvæ of beetles. Of this number the great Lebia[2] follows the Colorado beetle wherever it goes, and appears to

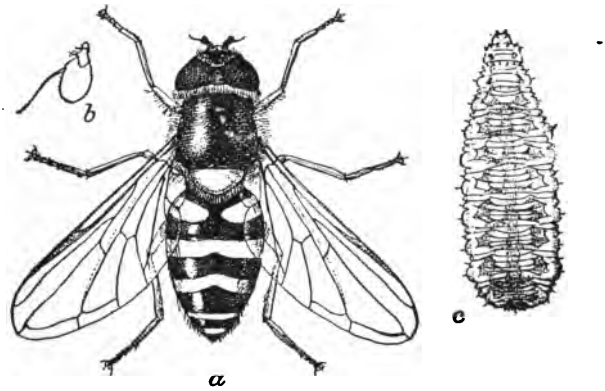

Fig. 20.—Syrphus-fly (*Syrphus ribesii*). *a*, Fly; *b*, lateral view of head; *c*, larva or active immature form. All much enlarged. (Author's illustration, U. S. Dept. Agr.)

have a very considerable effect in limiting its overproduction. Soldier-bugs[3] (fig. 19) of several species attack and kill soft larvæ of beetles and of moths. Other important predatory enemies of noxious insects are syrphus and robber flies, spiders, and daddy long-legs or harvestmen. The syrphus flies[4] (fig. 20) are particularly useful in destroying aphides. Wasps of many forms provision their nests with the larvæ of beetles and of moths, and certain species of mites help in reducing insects of pestiferous habits.

[1] Coccinellidæ. [2] *Lebia grandis*. [3] *Podisus* spp. [4] Syrphidæ.

Several kinds of birds, as also mammals, amphibians, and reptiles, are well-known enemies of noxious insects, and domestic fowls are of considerable value as destroyers of larvæ, especially such as are not hairy, like the "slugs" of asparagus and potato beetles.

Among beneficial birds, quail are important enemies of such pests as the potato beetle and boll weevil. Mammals include skunks, which kill great numbers of May beetles. Toads of the amphibians are particularly useful as insect destroyers. Chickens, ducks and turkeys are all used in a practical way by farmers for disposing of a variety of insects. Turkeys appear to be naturally adapted as substitutes for "hand-picking" tomato or tobacco worms and are actually employed and loaned for such purposes, and swine are equally fitted for the destruction of white grubs and other subterranean pests.

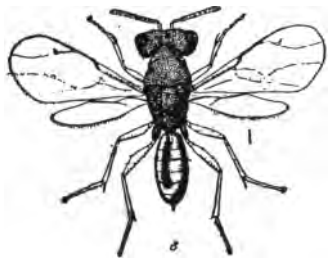

Fig. 21. — *Pteromalus puparum*. Male. Highly magnified. (Author's illustration, U. S. Dept. Agr.)

The parasitic enemies of noxious insects are legion, but their activity as useful allies to the farmer is to a large extent dependent on atmospheric conditions. As a general rule also they seldom appear in their greatest numbers until their injurious hosts have done more or less damage. Their principal usefulness, then, is in so decimitating the numbers of noxious species in one season that few are left to prey upon crops the following year.

The principal useful parasites belong to the family Hymenoptera, four-winged creatures of wasp-like appearance and variable size. Of these are the ichneumon flies,[1] chalcis flies,[2] braconids,[3] the egg parasites[4] and some others.

[1] Ichneumonidæ. [2] Chalcidoidea. [3] Braconidæ. [4] Proctotrypidæ.

An excellent example of the value of parasites as insect destroyers is afforded by the imported cabbage worm. One of its parasites, *Pteromalus puparum* (fig. 21), destroys in some seasons from 80 to 90 per cent. of these "worms." Another parasite, *Apanteles glomeratus* was purposely introduced by the United States government about 1883. During the autumn of 1904 this species held its host under complete control in the District of Columbia, killing every "worm" which came under the writer's observation. This species is shown in figure 21*x*.

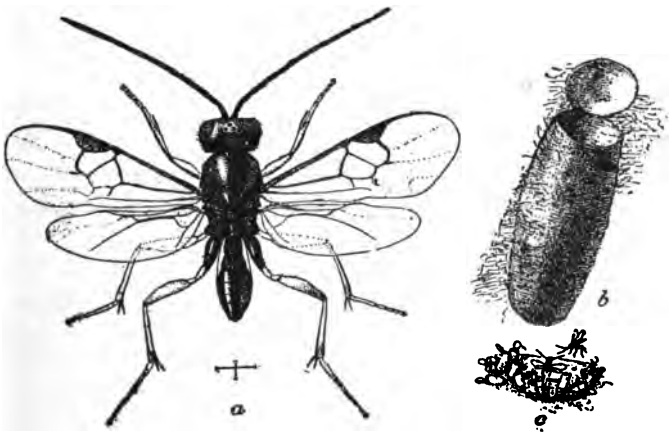

Fig. 21*x*.—*Apanteles glomeratus*. *a*, Adult fly; *b*, cocoon; *c*, flies escaping from cocoons *a*, *b*, Highly magnified, *c*, natural size. (Author's illustration, U. S. Dept. Agr.)

CHAPTER II

PREVENTION BY FARMING METHODS

HAVING shown in a general manner what is desirable for the best understanding of the subject under consideration, it is next in order to point out how this knowledge may be utilized in the prevention or mitigation of injury.

A knowledge of the origin and distribution of insects enables us to judge of the probable and ultimate spread of introductions from abroad and from one portion of our country to another. Thus we can predict, with a considerable degree of certainty, that certain species will not be injurious beyond certain boundaries, and that others will widen their range beyond known limits. Knowing the effects of atmospheric conditions, of heat and cold, dryness and humidity upon insect reproduction, we can be forewarned of injury and can plan accordingly. Experience having taught that the clearing of uncultivated or neglected land is almost certain to be followed by depredations of insects which had inhabited the wild plants and weeds, we are enabled to plant such crops as will be least affected by these insects. Knowing what insects are controlled by predaceous, parasitic and other enemies, such as beneficial insects, contagious diseases, wild and domestic animals, we can in many cases, untilize these natural agencies in our warfare against them.

Most of the different farming methods which will be considered are of use in combatting insect enemies of cereals; in short, without their employment it is impossible to avoid losses from these insects, as it is seldom practicable to use insecticides on growing grain. The usefulness of many of these methods is due to the slow spread of many species except at more or

less regular periods of migration and the strong tendency which many have of depositing their eggs in the same field where they have bred or hibernated.

The value of these methods in the treatment of the Hessian fly is summed up by Prof. F. M. Webster in the statement that "four-fifths of its injuries may be prevented by a better system of agriculture."

SELECTION OF PLACE AND TIME FOR PLANTING

With a knowledge of the insects which attain their highest development in sandy locations, in marsh land or in the neighborhood of woodland, we can prepare for attack from them after the ground has been cleared for planting. Much depends upon a judicious selection of the crop to replace weeds or to be grown in forest clearings or in land that has long laid waste. Unfortunately the crops frequently selected for planting in new land are the very ones most subject to attack, and if farmers generally are to preserve their crops from insect injury they must employ new tactics. Corn and other cereals, potatoes and strawberries are crops especially attractive to insects which have developed in unused land. They should therefore not be planted in new land until after some less susceptible plant be used as a first crop. Buckwheat and clover are less likely to be injured.

Corn should not as a rule be planted in marshy tracts or in reclaimed river beds owing to the danger of injury from bill-bugs, root-worms, wireworms and the like. Nor should corn follow wild grasses, which are liable to be affected by the same classes of insects as well as cutworms and white grubs.

Next in order is the choice of the proper time to plant to avoid insects which are liable to attack the crops which we intend to grow. With early and late planting must be combined occasional planting between two generations of an insect, and the timely disposal of the crop, particularly if this is damageable.

Late planting is practiced against numerous insects with excellent success, the object being to have the crop appear *after* the disappearance or dispersion of the insect whose ravages are feared. It is, in fact, a standard remedy against some insects.

THE MAINTENANCE OF VIGOROUS GROWTH

If plants be weakened through atmospheric or other cause or through a combination of unfavorable conditions they are as a general rule more subject to injury by insects, but there are many crop plants, as for example certain varieties of wheat, that the ranker the growth the more they are subject to infestation by such insects as the Hessian fly.

Some have claimed that weak plants only are subject to injury, and that plants might be grown by artificial methods for the production of such great vigor that insects would not seriously damage them. Although this might be possible with a limited number of plants, we can not now procure all of the most favorable conditions. As an instance, we have only to cite the reported successful use of kainit and nitrate of soda as a remedy for wireworms and some other insects in New Jersey, and their failure when applied in other states. Possibly soil and atmospheric conditions have in some instances had some bearing upon these failures. Most failures, however, are due to wrong methods.

BURNING OVER FIELDS AND WASTE LANDS

A farm practice in favor in many regions against cereal-feeding insects consists in burning over fields after harvest or before plowing. It affects particularly such insects as hibernate on or just below the ground. Among well-known pests that can be reached by this method are cutworms, many of which live all winter long above the earth's surface partially grown, also webworms, grasshoppers, aphides and plant-bugs, and some forms of beetles and other insects which hibernate in the adult stage at or near the surface.

CROP ROTATION

One of the best of farming methods is crop rotation, as it serves several purposes. If pursued on scientific principles it is not only a benefit to the land, but is one of the easiest means of preventing attack from insects, fungous and other diseases, and weeds. In a general way it may be said that crops of like kind, that is, belonging to the same botanical groups, and much subject to insect attack, should not be planted in successive years in the same fields. Thus it is inadvisable to plant corn in old wheat fields, and it is equally unwise to grow small grains after corn. Where insects occur like the bollworm, which attacks several plants, injuring tomato fruit, corn ears, bean pods, etc., in similar manner, still greater care is necessary in selecting the land for planting. It follows that it is bad practice to plant corn after tomatoes or tomatoes after corn, or to plant either of these crops in or near cotton fields.

Here is where a knowledge of botany sufficient to enable the grower to know the botanical families to which his crops, as well as the weeds, belong becomes of value; since with the exception of insects known as general feeders, most species feed by preference on one or more plants of the same botanical group. Thus an insect destructive to cabbage will attack any cole crop, such as turnip or radish, and weeds such as wild mustard and pepper-grass; hence care should be used not to plant cabbage in fields in which the other plants have grown. The same rule holds with plants of the cucumber kind. Melons should not follow squashes, nor pumpkins cucumbers. Rotation of crops is practically the only means of dealing with some of the most important insects, among which are the western corn root-worm. Where diversified farming is practiced, such leguminous plants as crimson clover and cowpea are most useful as alternates, because valuable as soil restorers, and not as a rule subject to serious insect injury.

DIVERSIFIED AGRICULTURE

Entire plantings are frequently failures because growers rely on single, or, at best, two or three crops for a livelihood. The practice of growing large areas to cotton in the South is an example. Occasionally this is varied by corn or tobacco, and all three crops are likely to be injured by the same insects, *e. g.*, by the bollworm, corn-ear worm or tobacco budworm, as this one species is variously termed. In Texas there was at one time the threatened danger of an abandonment of cotton culture owing to the rapacity of the boll weevil. The large appropriations that have been made available by Congress for the control of this pest should result in materially reducing the losses occasioned by it, which now bids fair to seriously hamper the production of this staple which nets our country $500,000,000 or more annually. The melon or cotton aphis has done great damage in Texas since the beginning of the new century and various crops in the South are threatened with new pests. It is quite a problem, therefore, to decide what may be grown most advantageously.

Other striking illustrations of the danger of cultivating a single crop can be pointed out. In some years in the past it was simply impossible for truckers in parts of Maryland and Virginia to make a living from cabbage, or other cruciferous crops or from melons and other cucurbits, but by growing several crops of widely different kinds they make a profit.

In the Northeast the farmer does not have such problems with which to contend and yet raises many crops, keeping his hands busy nearly the year round, and there is no excuse for growers in the South and elsewhere cultivating only a few crops when by diversified or general farming losses from insects, from plant diseases, and from adverse climatic conditions could be avoided.

FALL PLOWING AND CULTIVATING

One of the best methods of deterring insects from injurious attack, comparable with clean culture, burning over, submersion and the like, is fall plowing and other ways of cultivating. The process may be varied by harrowing, disking, and raking, and sometimes in cases of serious infestation a cross-plowing is advisable. The object of fall plowing is to bring the insects that are feared to the surface where they will be exposed to cold and other elements and to natural enemies such as domestic and wild birds and mammals. This method is particularly valuable to prevent the recurrence of severe attacks and is beneficial for most forms of insects which hibernate under or near the surface of open fields, meadows and like places. It is particularly indicated for many insects affecting cereals, cucurbits and some other vegetables, and where corn and other crops subject to injury by white grubs, root-worms and wireworms and other subterranean insects, as well as cutworms, grasshoppers and others, are to be planted in sod or weedy land. Where the forms of insects mentioned are extremely troublesome, the land should be very thoroughly broken, and the insects, whether larvæ, pupæ, or adults, should be as much exposed as possible. This remedy is very effective in cold climates since the exposed insects are unable to obtain secure shelter before severe frosts.

Fall plowing should be practiced for most crops where it does not interfere with other methods of cultivation.

The numbers of the squash-vine borer can be greatly reduced by lightly harrowing the surface of infested fields after harvest so as to bring the cocoons to the surface, and then plowing in the spring to a uniform depth of six inches or more, so that the adults will not be able to issue.

Disking, or cultivation with a disk harrow, is particularly recommended against the fall army worm, which hibernates as pupa near the soil surface. A somewhat similar method of

treating lawns infested by army worms, and root webworms, consists in going over them thoroughly with a long-toothed steel rake.

CLEAN FARMING METHODS

The most valuable of all methods of controlling destructive insects, if we except the employment of insecticides, consists in the observance of clean cultural practice, and when with this we combine the judicious use of other methods, including mechanical ones, only moderate use of poisons, employed at the proper time, is necessary. It is a more or less complete safeguard against the bulk of insects that ravage our crops.

Clean farming should always be practiced in the growing of crops that are liable to severe insect injury. Where the character of a crop will permit, still more can be accomplished by using portions of the same or a similar crop as baits. In addition, it is also desirable to employ as trap crops such weeds as the insects normally affect and which already grow in the fields, while in many cases it has been found of value to plant weeds or other crop plants to lure the insects from the main crop. Clean methods of management, though indicated as protective against most insects, is a practical necessity where there are many species that injure fall crops, such as cabbage, turnip and other crucifers, and for such insects as pass the winter in rubbish in the fields that they have ravaged.

FARM INSPECTION

An old proverb, "An ounce of prevention is worth a pound of cure," is as applicable to man in relation to insects which injure his crops as to other matters which affect his well-being. Eternal vigilance is also the price of a good crop. The fact that the greatest injury due to such insects as army worms, cutworms, blister beetles and the like is accomplished before their presence is known, indicates the value of prompt action in the treatment of the crops affected. Too frequently attack is un-

noticed until damage is beyond repair, and this might be averted if the grower would only employ some simple farm practice like fall plowing.

Promptness cannot be too strongly urged, for the application of remedies if too long deferred may be useless. As soon as a crop is planted it should be inspected every few days for signs of injury. If plants growing under the same conditions make unequal growth, over a considerable area, the backward plants should be examined for evidence of insect work. Insect injury is manifested in different ways, as has already been described in the Introductory Chapter (page x).

After crops have made some growth, a weekly inspection will in ordinary cases suffice until the danger point has passed; and as attack usually begins on the borders of a field, by walking around it most forms of insect injury may be detected. Preventive work, such as clean culture, rotation and fall plowing, should be instituted as a part of the routine of farming; and if systematically pursued losses through insect ravages will be reduced to a minimum; while prompt action at the very outset of attack, in the application of insecticides or mechanical methods will, in exceptional cases, save the crop.

COOPERATION IN THE CONTROL OF INSECTS

The grower who institutes practical methods for the control of insects which menace his crops has a distinct advantage over one who does not. The enterprising farmer is enabled to obtain a good yield while the careless grower stands a chance of a money loss on his crop. It has long been recognized that insects of many forms are a direct benefit to the progressive man, who farms on scientific principles, enabling him to preserve his crops while the damage that may be done to his more careless neighbors enhances the market value of what the scientific farmer raises. This is a decidedly narrow-minded and selfish way of looking at the subject.

Large corporations like seedsmen, canners, and picklers, plant very extensive areas and employ others in growing the same crops. Such firms provide seed and machinery, and keep posted on what will benefit not only their own interests, but those who labor for them. This applies to the means of controlling insects, including the purchase of insecticides and spraying apparatus, and by purchasing at wholesale they greatly reduce the cost for themselves and their co-laborers. The scope of this work might be extended (and perhaps is in use in some measure) to those who grow on a smaller scale, the farmers of a given locality having a community of interests pooling their interests for the purpose. Growers having small areas are often so little troubled with insects that it does not pay to buy expensive outfits; and insecticides cost at retail frequently two or three times as much as when purchased in quantity. For example, bisulphid of carbon, a standard remedy for the melon aphis, bean and pea weevils and root-maggots, costs only 10 cents a pound in fifty-pound lots, and from 20 to 30 cents when bought in smaller quantity. This difference could be saved by the co-operation of several neighbors, and it could be extended to the purchase of expensive spraying outfits.

Co-operation is of especial value in the control of insects such as the squash bug, cucumber beetle, harlequin cabbage bug, and cabbage looper, that cannot be held in subjection by ordinary poisons. If growers who suffer most could induce neighboring farmers to employ clean farming methods and crop rotation, the ravages of these pests would be greatly reduced. The harlequin cabbage bug is quite resistant to poisons, and since about the year 1900 it has been so nearly exterminated in its northern range, that if farmers would work together when it again makes its appearance northward and use trap crops over large areas, for example over townships, the insect might be prevented for several more years from regaining its lost foothold. This, with clean methods of cultivation, would leave little else neces-

sary to keep the insect down, unless by carelessness it were permitted to return unmolested to its old haunts. Immeasurable benefits would undoubtedly accrue by the subordination of self-interest for the common weal. Indeed this subordination is only apparent and it has been pointed out that one of the best, as it is the noblest, methods of self-help consists in helping our fellow men.

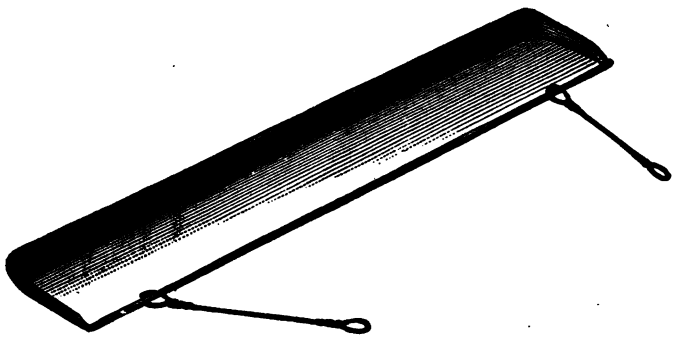

Fig. 21*y*.—A simple coal-tar pan to be drawn by hand (After Riley)

CHAPTER III

MECHANICAL METHODS OF DESTROYING INSECTS OR PREVENTING INJURY

MANY valuable mechanical methods of controlling insects are employed, such as hand-picking, "bugging" or beating, collecting in nets or in hopper-dozers, ditching, disking, driving and others.

Hand-picking is useful for large conspicuous inactive insects, such as the squash bug, potato beetle, cutworms and similar caterpillars. It is one of the simplest measures that can be employed, and is valuable where other means cannot be used and where labor is cheap.

Bugging.—This term is often used for jarring and beating insects from low plants into pans containing water and a thin scum of kerosene. The water prevents the insect from escaping, and the floating kerosene kills every insect which comes in contact with it.

Collecting in nets.—Hand nets of muslin or cheese-cloth such as school children employ for the capture of butterflies, are useful against some insects which affect truck crops. Among such are the tarnished plant-bug, which affects about equally vegetables and small fruits. By sweeping over the plants to be protected and the weeds and grasses of the vicinity, thousands can be captured in a short time, and they can then be killed by throwing them into a fire or into hot water.

Collecting in hopper-dozers.—Many forms of these death-dealing devices are in use for grasshoppers (see figs. 21*y* and 21*z*) and for leaf-hoppers, which will be described in the discussion of those insects.

Brushing methods.—Different methods of brushing more or less sluggish insects from their cultivated food plants have been in vogue for many years. Potato beetles and their larvæ may be brushed from potato plants by means of a short-handled broom, a second person to follow dragging by horse power a bundle of brush or a harrow to crush the insects and bury them. This process is simplified in the treatment of the asparagus

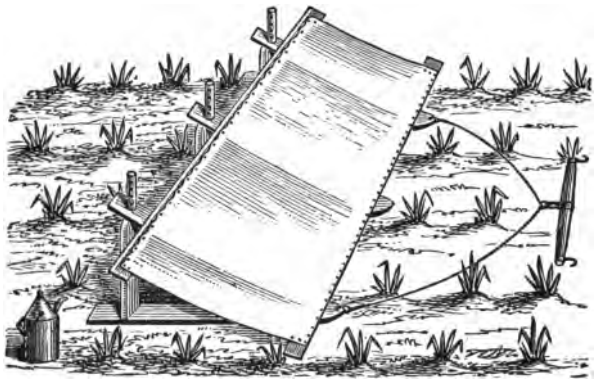

Fig. 21*z*.—A canvas hopper-dozer to be drawn by horse. (After Riley)

beetles. It consists in beating or brushing the insects from the plants with a stick so that they will drop to the bare ground on a hot dry day. The larvæ are delicate creatures, crawl very slowly, and few are able to regain the shelter of the plants and die from exposure to the heated earth. A somewhat more complicated system came into rather extensive use in 1900 against the pea aphis. It is known as the brush and cultivator method, and at the time of writing is the best remedy that has been devised for this pernicious species. It will be described in discussing pea aphis remedies.

Cloth covering.—To prevent injury from some forms of insects to young plants before they are fairly above ground early in the season cloth coverings are used. A cheap frame may be

made by cutting a barrel hoop in two so as to form two semicircles, which are then placed at right angles to each other, and the lower ends inserted into the ground with the curve uppermost. This is then covered with gauze or similar material, held in place with earth packed about the edges, to prevent the beetles working under it. It is necessary to keep the plants covered only while they are young, and the same covering may be used year after year. Such covers are much used against the striped cucumber beetle, and radishes have been successfully protected from root-maggots.

Trapping.—Several methods of trapping insects are practiced with success. Trapping under boards, shingles, chips, etc., is useful for squash-bugs and cutworms and if employed properly will serve as a means of destroying many pests. In the case of cutworms poisoned baits are placed under such traps.

Pruning and the destruction of affected parts, practiced with benefit against many tree-borers, are useful methods for killing some vegetable feeders, *e. g.,* aphides or "lice" when congregated on seedstalks of crucifers, etc.

Miscellaneous mechanical remedies.—Such remedies as ditching, disking and driving are applicable to only a few forms of insects and will be mentioned in the body of the present work as remedies for those insects where described. Ditching is practiced against the army worm, as is also disking, and such insects as blister beetles and cucumber beetles may be driven by various means from cultivated fields.

Repellents.—Various substances have been advised in the past and are claimed by "knowing ones" to be valuable as preventives of insect attack, but comparatively few deterrents will stand a thorough test The best for use on vegetable crops will presently receive mention because of their value as insecticides or fungicides. These are: Tobacco; carbolic acid, used in emulsified form; Bordeaux mixture; kerosene emulsion; sulphur, when freshly applied; and fish-oil soaps. Certain substances like

ashes and road dust, finely pulverized and sifted on young leaves serve to drive insects to other clean leaves which should be poisoned. Substances which are of little or no practical use as repellents, for vegetable insects at least, are legion. Among those for use as topdressings, or about the soil of the plants, which do not commend themselves or which produce indifferent results are: Bone dust, soot, coal dust, liver of sulphur, lye, benzine, naphtha, naphthaline, alum water, salt, saltpetre, etc.

Bordeaux mixture is one of the most valuable insect deterrents and is particularly useful for flea-beetles, leaf-beetles and other foliage-feeders. Its value as a fungicide is too well known for further comment. The formula follows:

Into a 50-gallon barrel pour 30 gallons of water, and suspend in it 6 pounds of bluestone in coarse sacking. Slake 4 pounds of fresh lime in another vessel, adding water slowly to obtain a creamy liquid, free from grit. When the bluestone is dissolved add the lime milk slowly with water enough to fill the barrel, stirring constantly.

With insufficient lime the mixture sometimes injures the foliage, and it should be tested with a solution obtained by dissolving an ounce of yellow prussiate of potash (potassium ferrocyanide) in one-half pint of water. If there be insufficient lime in the Bordeaux mixture the addition of a drop or two of this solution will cause a brownish-red color, and more lime should be added until no change takes place when the solution is dropped in. Use the Bordeaux mixture promptly, as it deteriorates on standing.

Stock solutions of both the bluestone and lime may be kept for any length of time. Make the stock bluestone by dissolving in water at the rate of 2 pounds to the gallon. The stock lime is slaked and kept as a thick paste. Cover both mixtures, to prevent evaporation and keep the lime moist. For the 50-gallon formula add 3 gallons of the bluestone solution to 50 gallons of water, and introduce the stock lime slowly until there is no reaction with the testing solution.—GALLOWAY.

CHAPTER IV

INSECTICIDES AND THEIR USES

THE most approved means of controlling insects consists in the use of poisonous mixtures administered in the form of a spray, wash, or dry powder in conjunction with such methods of farming, as fall plowing and rotation of crops, which tend to decrease the chances of injury from insect attack.

Insecticides, or the substances used for the destruction of insects, may be classified as internal or stomach poisons, and external or contact poisons. The former kill by being eaten with the insects' food, the latter by direct contact causing corrosion of the bodies of the insects, or the closing of their breathing pores.

STOMACH POISONS, ARSENICALS, ETC.

Paris green.—Of the various internal poisons in use against insects none are so valuable or so much used as Paris green,[1] the standard remedy against biting or chewing species, which include the bulk of injurious forms, such as cutworms and other caterpillars, beetles, grubs, slugs, etc. Paris green is applied in two ways,—dry and as a spray, the latter being the method most extensively used, as it is cheaper and more effective, answering all the purposes to which dry powders are put. A spray is prepared by combining one pound each of the poison and fresh slaked or quick lime with from 75 to 150 gallons of water. A slight excess of lime is advisable. A somewhat

[1] Paris green is now chemically known as *copper aceto-arsenite;* in other words, it is a chemical compound of oxid of copper, acetic acid and arsenious acid, and when properly combined the proportions of the different chemicals are as follows: copper oxid, 31.29 per cent.; acetic acid, 10.06 per cent.; arsenious acid, 58.65 per cent.

stronger mixture can be used on resistant plants like potato, and a weaker solution (1 to 200) must be made for young and delicate foliage.

For the proper preparation and application of this and other sprays a sprayer or spray pump is *necessary*. The Paris green should first be mixed with a small quantity of water into a thin paste before the bulk of the water is added, and should then be thoroughly mixed by churning in the force-pump. As the mixture is only a mechanical one the Paris green tends to sink to the bottom, and to avoid this it must be constantly stirred while being applied, otherwise the mixture near the bottom of the tank or reservoir will become so strong as to scorch the foliage. Care should be exercised in the purchase of a spray pump that it be equipped with a proper agitator.

When applied dry, it is generally mixed with from 10 to 20 parts of flour, plaster, or lime. This remedy affords best results early in the season on young plants. It should be dusted on preferably when the dew is on, or after a shower, and by means of powder guns or bellows, or the so-called "dust-spray" machines, so as to cover the plants and leave as little surface as possible for food for the first-appearing insects.

It is often advisable to use Bordeaux mixture in combination with an arsenical, especially if a disease is present. This is a valuable insect repellent as well as a standard fungicide, and it operates also against different forms of blight and other diseases which may threaten the crop. It is used as a diluent instead of water and in the same proportions, and prevents scorching. Its preparation is discussed on page 28.

Paris green is more usually recommended for general purposes because it is known to most farmers, can be obtained in drug stores anywhere, and because of its supposed cheapness. Its use, however, is being superseded in some degree by arsenate of lead and other arsenicals.

Paris green is very frequently adulterated by unscrupulous

dealers, *e. g.*, with white arsenic, which makes the liquid mixture (containing an excess of free arsenic) still more scorching in its effects on vegetation. The New York (Geneva) Experiment Station has ascertained that this insecticide possesses about one-third the *fungicide* value of Bordeaux mixture.

Arsenate of lead, lead arsenate or "disparene" has the advantage of being less harmful to growing plants and adheres better to the leaves than other arsenicals. It is less apt to burn delicate foliage, hence does not require the same care in its application as is necessary for Paris green, and can, moreover, be obtained ready made on the market. Numerous brands are for sale, and care should be exercised to obtain a good quality as some alleged arsenate of lead preparations contain free arsenic. The commercial preparations are mostly like paste or putty and must be worked in a little water in a bucket before being added to the spray tank.

It is prepared by combining acetate of lead (6 or 7 parts) with arsenate of soda (3 parts). In spraying it can be employed at any strength from 3 to as high as 12 pounds to 100 gallons of water without injury to most vegetable crops. Its cost at present writing is 12 to 15 cents a pound when purchased in bulk. Quite a number of other arsenicals have been more or less used as insecticides and some of these are of considerable value while others have no especial advantages over Paris green or arsenate of lead, or are decidedly inferior.

London purple was formerly used in spraying. As sold in the market its composition is unstable owing to its being apt to be adulterated, and it is very caustic, hence liable to scorch tender foliage. For these reasons it is rapidly going out of use. As a spray it is applied in the same proportions as Paris green, as is also arsenite of copper.

Arsenite of copper (Scheele's green or "green arsenoid") is of similar composition to Paris green, and is even superior owing to its more rapid effects and less liability to produce scorching. It is, however, not as yet so readily obtainable

White arsenic (pure arsenious acid) is the active principle of all the arsenicals. It is particularly dangerous when used alone in solution, but as it is the cheapest of the arsenicals it is employed in the preparation of poisoned baits for cutworms and grasshoppers. Combined with lime it forms *arsenite of lime.*

Arsenite of lime has been highly recommended by those who have tried it. It is prepared by such methods as follow:

The Kedzie formula: Boil 2 pounds of white arsenic and 8 pounds of sal-soda 15 minutes in 2 gallons of water. Put into a jug, label "poison" and lock it up. When ready to spray, slake 2 pounds lime and stir into it 40 gallons water, adding a pint to a quart of the mixture from the jug.

Formula No. 2: Boil together 1 pound white arsenic, 2 pounds lump or stone lime and 3 gallons water. Dilute with about 200 gallons of water before spraying.

Still other arsenicals possess insecticidal properties. Of these "pink arsenoid" has given good results experimentally. "White arsenoid" has been practically withdrawn from the market. "Paragrene" is reported as having equal insecticide value with Paris green, is about as likely to burn foliage, but remains longer in suspension.[1]

The arsenicals are also useful in the preparation of poisoned baits, which will be discussed in the consideration of cutworms and locusts or grasshoppers.

Harmlessness of arsenicals when properly applied.—Chemical analysis has shown that cabbage which has been dusted or sprayed with an arsenical in the way prescribed, and then prepared for cooking in the usual manner a week later has not even a trace of arsenic remaining. The use of arsenicals against cabbage worms is almost universal, although growers are sometimes loath to acknowledge the fact for fear of the loss of customers who are not fully acquainted with the harmlessness

[1] More detailed directions for the preparation of the arsenicals here discussed are given in Farmers' Bulletin 127, U. S. Department of Agriculture.

of this remedy. There are no authentic recorded instances known to the writer of poisoning from the consumption of cabbage or other vegetables treated with an arsenical. According to Gillette, 28 cabbages dusted in the ordinary way would have to be eaten by a human being at one meal in order to produce poisonous effects! It is preferable, however, in order to avoid all danger, to use other insecticides in the case of vegetables soon to be eaten.

CAUTION.—It is advisable in using all arsenicals to see that they are correctly labeled and kept under lock and key, as they are dangerous to human as well as other animal life.

The utensils employed in preparing arsenical mixtures should be thoroughly cleansed after use.

Lime (oxid of calcium) possesses considerable value as an insecticide and repellent, its efficiency being in proportion to its dryness and caustic quality. It is more effective against delicate and moist insects, such as the larvæ of asparagus and potato beetles and root-maggots. For leaf-feeding species it is sifted on the plants and kills by contact, literally burning holes into the soft bodies of the larvæ which it touches. Certain root-maggots and white grubs are without doubt largely attracted to gardens by the presence of manures and decomposing vegetable matter, and if this be powdered with lime, finely sifted, it soaks into the material with rains and, moreover, acts as a deterrent, especially against the flies which produce the root-maggots. It is useful also for slugs or snails.

Fresh air-slaked or quick lime should be used, as when stale it loses its caustic properties.

Gas lime is of value in clearing infested land of white grubs before planting some crops. It is a refuse product of gas plants and may be obtained frequently merely for the cost of hauling. It contains much gas in a crude form, and to be of greatest value should be fresh so as to give out a strong gassy odor for several days after application. When applied to lawns it is

sprinkled over the surface as a top dressing. In fields of potato it should be applied between rows and covered by earth, by drilling or other process, as there is a possibility of injury to plants, and this method should be used experimentally at first. The amount to use will vary according to the degree of infestation by white grubs and other conditions. It has been employed at about the rate of 4 barrels to 100 square feet of ground on a lawn with the result that the spring after application all forms of vegetation, including weeds, came up, and only five or six white grubs could be found. In Europe gas lime has been used with some success in connection with other remedies for wireworms at the rate of 1½ tons to the acre.

The best time to apply the lime is in September, after the crop is made.

CAUTION.—There is always danger to plant life in the use of gas lime, hence before employing it on growing crops on a large scale it should first be used experimentally.

Hellebore, or white hellebore (*Veratrum album*) is less dangerous than the arsenicals, hence has some votaries for its use on cabbage and other plants soon to be eaten. Its use is open to the same objection as pyrethrum that it loses its insecticidal properties by exposure to the air. It is also poisonous to man and domestic animals. It is a specific against the slugs or false-worms (none of which commonly affect vegetables), which attack raspberry, currants and other bush fruits. As many truck-growers raise bush fruits it might be added that it is used in both dry and liquid form, but can be applied more thoroughly as a spray, ½ ounce of powder to 2 gallons of water. Dr. James Fletcher recommends its employment as a remedy for certain kinds of cabbage pests, including "worms" and root-maggots. On the latter it is applied at the rate of 2 ounces of powder to the gallon of water, and applied with a force-pump about the infested roots.

CONTACT POISONS

Kerosene emulsion is the standard remedy for sucking insects such as aphides or plant-lice, plant-bugs and the like, and is of value against other soft-bodied insects, which cannot for different reasons be safely poisoned by Paris green and similar insecticides. The best form for ordinary use is the kerosene-soap emulsion, made by combining 2 gallons of kerosene, ½ pound of whale-oil soap, or 1 quart of soft soap with 1 gallon of water.

The soap should be dissolved in boiling water and then poured while boiling (away from the fire) into the kerosene. The mixture is then churned violently for about five minutes by means of a force-pump and direct-discharge nozzle throwing a strong stream by pumping the liquid back upon itself. At the end of this time the mixture will have become of the consistency of thick cream. Properly prepared an emulsion will keep almost indefinitely, and should be diluted only as needed for use. For most insects, except scales, the staple emulsion should be diluted with from 15 to 20 parts of water. A 10 per cent. solution, or even stronger, is sometimes necessary.

In the preparation of kerosene emulsion a force-pump is a necessity, since, if not made according to directions, a perfect emulsion is not formed. There is then danger of injury to the plants by the kerosene, as also useless waste. There is also danger and waste if the insecticide is not applied by means of a fine nozzle in the form of a *spray,* which should be fine and mist-like. It should be sprayed only long enough to cover the plants and not so that the liquid forms into globules and runs off.

In the practical application of this insecticide certain setbacks are frequently encountered. One of these is due to the fact that aphides and many other sucking insects feed more or less exclusively on the under surface of leaves, which necessitates

an under-spraying of the leaves in order to reach the pests. This is frequently of difficult accomplishment owing to the thick growth of the plants after they have got well started, and the fact that many leaves overlap others. An example of the difficulty experienced in spraying for aphides is afforded in the pea aphis, particularly where peas are grown broadcast, which does not permit the driving of a machine through the fields. The leaves interlace and intertwine in such a manner that the insects cannot be reached. The same is the case with melons after they have attained any growth. There is also danger of injury to the vines by the wagon wheels and the horse in going through the fields.

For success with this remedy it is in many cases absolutely necessary that the emulsion should be applied so that it will actually come in contact with or strike the insects against which it is directed.

Kerosene-milk emulsion is sometimes used, but it is hardly as satisfactory as kerosene-soap emulsion, since the soap in the latter has also considerable killing and repelling power.

Carbolic-acid emulsion.—For some purposes it is desirable to add to kerosene emulsion a quantity of carbolic acid, *e. g.*, for the treatment of various root-infesting insects, such as root-maggots affecting seed-corn, onion, and cabbage. This emulsion is prepared at the rate of 1 pound of soap, 1 gallon of water, and ½ gallon of *crude* carbolic acid, and is diluted with from 35 to 50 parts of water. It has been found quite effective against root-maggots, the plants showing no injury due to the insecticide. It should be applied a day or two after the plants are up, or, in case of crops that are transplanted, the day after they are set in the field, and should be repeated every week or ten days until about the latter half of May. Carbolic acid is at once a repellent and a contact and stomach poison. It should be handled with care as it is corrosive!

Corrosive sublimate (Bichlorid of mercury) is prepared by

mixing 2 to 2¾ ounces of the poison with 15 gallons of water. The poison is first dissolved in 2 gallons of water, and more is added to make 15 gallons. This is allowed to stand 5 or 6 hours, and the solution agitated several times. This is a fungicide as well as insecticide, and is useful both for potato scab and the potato scab gnat. Seed potatoes are soaked from an hour and a half to three hours in this solution before planting. As corrosive sublimate is a violent poison, unusual care should be exercised in handling it. It should not be mixed in metallic vessels, nor exposed where it might be eaten by stock.

Formalin is prepared by mixing 8 ounces of 40 per cent. solution with 15 gallons of water, and is used for the same purposes as corrosive sublimate, but is less poisonous. Seed potatoes are immersed two hours.

Soap preparations.—Soap solutions are valuable as washes in the control of noxious insects. Both hard and soft soaps are used, but "whale-oil" soaps, usually manufactured of fish-oil, are of greatest value. A solution of fish-oil soap is prepared by dissolving 1 pound of the soap in from 4 to 10 gallons of water. On some hardy plants a strength of 1 pound of soap to 2 gallons of water can be used, but this is harmful to delicate plants and must be employed with caution. A wash of 1 pound soap to 6 or 8 gallons is of most value for aphides, minute leaf-bugs, leafhoppers, and thrips, and some forms of small larvæ. These soaps possess no particular advantage, however, over kerosene-soap emulsion and are, in fact, less effective against vegetable-feeders. Castile or "neutral" soaps, among which are ivory soap, are much used on plants grown under glass and as a means of arresting the ravages of "red spider" and the same insects that have been mentioned.

Cold and hot water are properly speaking contact insecticides of value in the destruction of minute insects such as aphides. A strong spray of ice cold water applied to louse-infested plants is a very useful remedy, but hot water is still more effectual

as a means of riddance of these pests. The latter is most applicable to such plants as cabbage, which withstands a high degree of temperature, which would be hurtful to less hardy plants. A water thermometer is employed, and care is observed that the temperature does not reach far above 150°, the scalding point for most plants. From 125 to 135° is sufficient for the destruction of most insects, but applied still hotter where possible is still more effective. Cabbage will withstand a temperature of 180° without special harm. When setting out cabbage and some other plants they can be freed from "lice" by dipping them into water heated to between 125 and 150°. Hot water cannot be thrown in a spray owing to its cooling too rapidly, and it is necessary if it is to be thoroughly effectual for it to actually strike the insects which it is desired to destroy. Where only a few plants are to be protected and it is possible to reach the "lice" with water applied with a garden hose, syringe or spraying machine their work can be checked. Such as come in direct contact with a *stiff* spray at an ordinary temperature are unable to survive, while many that are dislodged cannot return to the plants as most of them are wingless and unable to crawl any distance, particularly if the ground be dry and hot.

INSECTICIDES WHICH KILL BY SUFFOCATION

Under this caption will be included insecticides which do not properly fall under the heading of either stomach or contact poisons. Of these are pyrethrum; tobacco, which acts both as a repellent and, when vaporized, as a destroyer of aphides and thrips; bisulphid of carbon and hydrocyanic-acid gas, two deadly gases, and some others.

Pyrethrum.—Several forms of insect powder, the pulverized dry flowers of different forms of daisies, are on the market under such names as Persian and Dalmatian insect powder. One of these is buhach, made exclusively from *Pyrethrum*

cinerariæfolium. It was carefully tested years ago by the Department of Agriculture at Washington, and although not useful against all forms of insects, is very valuable for household pests, aphides, and small plant-bugs and caterpillars. It is best used dry by dusting the plants affected with an insufflator or bellows while wet with dew. It acts by closing the breathing pores of the insects, and has the advantage of being harmless to man and the higher animals. It is also used in liquid form, as a spray, the buhach being first mixed with enough water to make a thin paste and allowed to stand about two hours, after which more water is added to bring it to the desired strength, the usual proportions being: 2 ounces to 5 gallons of water. An alcoholic decoction is also sometimes used.

Under different trade names, pyrethrum is placed on the market in hermetically sealed tin cans, so that it retains its full strength until used. Powders that are not packed in tightly sealed cans lose their strength, and are therefore less effective. In small lots pyrethrum costs 10 cents an ounce; if six pounds are purchased it can be had for about 50 cents a pound.

Tobacco is an old-time remedy for many insects, and still in vogue among a certain class of farmers and florists, but in recent years it has been largely replaced by other and more approved insecticides, such as Paris green and kerosene emulsion, and in greenhouses by the hydrocyanic-acid gas process. The method of its application varies according to the crop affected and the insect. Where tobacco stems and other refuse can be easily obtained from the factories it is advisable to use it as a protection against certain species of insects.

For the striped cucumber beetle and melon aphis, it is used by sprinkling the hills, particularly when the soil is moist, with refuse dust. Thus used it has the advantage of acting as a fertilizer and mulch for the plant, as well as being a repellent to the beetle and other insects. Applications must be repeated after rainfall.

Nicotine extracts and powders are extensively used by florists as general fumigants for aphides, thrips, white fly, and other small and soft-bodied insects in greenhouses. These extracts are manufactured by a number of firms who advertise chiefly in florists' journals. They contain a much larger proportion of nicotine than decoctions, and are proportionately more effective. They are used in various ways: Dry fumigants are placed in shallow pans and a few drops of kerosene poured on to facilitate ignition. These burn slowly, producing a smudge which is fatal to aphides and similar insects. The liquid preparations are evaporated over an alcohol lamp, or are "painted" on steam pipes, or hot irons are put into the receptacles.

The amount of nicotine solution to use depends upon its strength (varying from about 35 to 85 per cent. nicotine), the plants to be treated, the size of the frames or greenhouse and the construction of the latter, whether tight or loose. A preliminary test, on a small scale, is therefore a prerequisite to the use of a nicotine fumigant. Follow the directions accompanying the preparation used and increase or decrease the strength as necessary. If cucumbers are being fumigated, a smaller amount may be desirable. One of the most widely known of these nicotine solutions has been used with great success at the rate of 5 or 6 teaspoonfuls of the liquid to 8 quarts of water vaporized in 5,000 cubic feet of greenhouse space. Used thus on cucumbers at night it did not injure the plants, while thrips which infested the plants were killed. Aphides are more easily killed than thrips, while white flies require still longer exposure and repeated applications.

After treatment plants are carefully syringed with whale-oil or similar soap and the house ventilated. A second fumigation is sometimes given, allowing the tobacco smudge to remain over night. A surplus of moisture is to be avoided, as it induces spot, mildew, and similar fungous diseases.

Sulphur, applied dry in the form of "flowers of sulphur," is

a veritable specific for "red spider" on certain plants grown under glass. It is also applied dry mixed with an equal bulk of air-slaked lime, and by means of a powder bellows. It is also used in conjunction with kerosene emulsion or soap washes, added in the proportion of 1 to 2 pounds to 50 gallons of the spraying solution. It is first mixed into a paste. As a vapor it is exceedingly harmful to plant life, hence should not be used as a fumigant in forcing houses or in a confined structure.

Bisulphid of carbon (CS_2), a specific against insects affecting stored grain and other products, has a special value in the treatment of some forms of insects affecting vegetable crops, more particularly aphides, and root-feeding insects, such as root-maggots of cabbage and onion. This reagent, when pure, is a colorless liquid and has a powerful and disagreeable odor; it vaporizes rapidly when exposed to the air, is highly inflammable but not explosive, and is deadly to all forms of animals, including human beings. Its field of usefulness is among such insects as we cannot reach with poisons by direct contact or through their foods.

The method of applying bisulphid of carbon varies according to the nature of the plants affected and the insects to be destroyed. The method of treating the melon aphis and root-maggots will be described in the consideration of those insects.

PROPRIETARY INSECTICIDES

Numerous proprietary insect destroyers are on the market, and their number is increasing. Analyses of these are being made, with the result that although a few are not without value they are as a whole decidedly inferior to approved combinations advised by entomologists, of the character that are mentioned in preceding pages; in fact, they occupy the same relation to standard insecticides that quack nostrums do to the prescriptions of reliable physicians, or preparation of recognized value

and known composition.[1] Among proprietary insecticides that have been reported to be found by analysis of little or no value or too costly are those bearing names suggestive of "sure pop," "bug shot," "certain death," "kill-em-quick," and certain lice and "vermin" exterminators, roach destroyers, etc.

On this head it is advised that in view of the fact that so many proprietary insecticides are either fraudulent or *extremely expensive,* considering the value of their ingredients, it would be well to make sure of the composition and value of each before purchasing.

Among the most useful proprietary remedies are nicotine solutions or tobacco extracts and powders which are not mixtures or nostrums, but just what their manufacturers claim for them.

INSECTICIDE APPARATUS

In the application of insecticides different types of apparatus are necessary, according to whether the material used is to be applied dry in powder or as a spray. The types necessary for the former are simple, the spraying devices are numerous and many efficient sprayers and like mechanisms are on the market.

For dry application, such as pyrethrum, sulphur, and Paris green mixed with flour, powder bellows or atomizers costing about $2 are much used, particularly for gardens or where small areas in larger fields are infested.

For spraying.—No stronger evidence of the progress in economic entomology could be cited than the number of firms engaged in the manufacture and sale of spraying apparatus.

Such crude mechanisms as are for sale at from 75 cents to $2 or $3, both under the title of syringes and sprayers, can scarcely be recommended for up-to-date work. They do not, as a rule, produce a *true* spray; they are too apt to get out of

[1] Such as paregoric, Rochelle salts, Seidlitz powders, and various extracts, elixirs, tinctures, mixtures, solutions, anodynes, etc.

order and therefore do not last longer than a season or two. The want of an instrument to fulfill modern requirements for a *fine* spray is met by various manufacturers in the form of knapsack sprayers, bucket pumps and barrel spray pumps.

The spray is obtained by a hose attachment and different forms of nozzles, of which the vermorel type is the best.

The knapsack sprayer is a copper tank made to be strapped

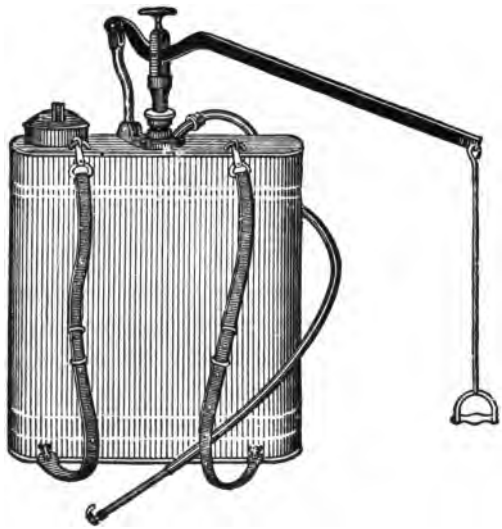

Fig. 22.—Knapsack sprayer

on the back of the operator (fig. 22). Within there is a small pump which is operated with one hand while the nozzle is held in the other. The handle may be removed, if desired, and the tank carried by hand instead of on the back. The cost is from $9 to $18. It is good for gardens and for moderate-sized plats on truck farms. Of its usefulness Mr. M. B. Waite, a pathologist of the United States Department of Agriculture, says in substance:

The barrel pump has nearly driven out the knapsack outfit

in commercial operations. In spraying several acres of cantaloupes once the writer was surprised to find that a man with a knapsack outfit could do the work at the same price as an outfit consisting of a barrel mounted on a sled drawn by a horse and operated by three men, one to pump and drive and two to carry the nozzles. The latter outfit, however, got over the ground so much more rapidly and saved so much time that it was mainly used. The objections to the knapsack pumps are numerous. It is hard to get the required pressure in the pump on account of its small size and instability. It is rather heavy to carry on the back and is very liable to leak, and the operator who can handle one all day without getting his back wet and some of the liquid down his neck is fortunate. As a rule, the low pressure obtained by the knapsack pump results in an inferior job of spraying, though with a strictly first-class vermorel nozzle this is not necessarily so.

Fig. 23.—Hand bucket pump

Bucket pumps.—Good hand bucket spray pumps of about the type shown in figure 23 may be had at from $6 to $7.50. They are of great value in the preparation of kerosene emulsion, which, as has already been stated (p. 36), should be applied as a fine mist-like spray. They may be used with ordinary or special buckets and a longer hose than figured (fig. 23) and may be necessary.

Barrel spray pumps.—These are the largest force pumps and useful both for the field and orchard. They are mounted on barrels or tanks and drawn for field and garden use on wheels, so geared as to straddle rows of vegetables, or a narrow sled may be made to serve the same purpose. A serviceable sled may

Fig. 23x.—Hand barrel spray with cart in operation in a cucumber field (After Orton, U S. Dept. Agr.)

be made by fastening planks across two pieces 2 or 3 x 4 inches and with rounded ends for runners. Two-wheeled carts may also be used for such an outfit. Such a one designed for spraying four rows of plants and from two sides at once is used by Prof. F. L. Washburn of the Minnesota Experiment Station (fig. 24).

Fig. 24.—A four-row sprayer. (After Washburn)

Nozzles.—One of the main causes of failure on the part of farmers to obtain good results from spraying is the use of inferior nozzles which are too often supplied by dealers. The vermorel type (fig. 24*x*), for sale (single) at about $1.25, is the best, having stood the test of 25 years and more of use.

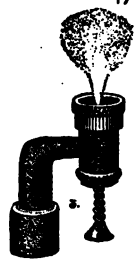

Fig. 24*x*.—Vermorel nozzle

REMARKS ON APPLYING INSECTICIDES

In the application of remedies 12 points are selected as important to be observed:

1. Be sure of the insect which is the primary cause of the damage.

2. Make certain that the best remedy or remedies are used.

3. When an insecticide is employed, ascertain if it is of standard quality, because if it is lacking in strength it will fail of its purpose. If not diluted according to directions, and if therefore too strong, there is danger of scalding or otherwise injuring the plants.

4. The preparation used should be properly prepared. Thus if kerosene emulsion is the remedy, it should be a *true emulsion* and *not* a mere *mixture* of water, soap and kerosene.

5. The best insecticide apparatus for the purpose for which it is designed should be obtained, and for vegetables it is necessary in most cases that a sprayer be used, and as often as not the spray must be applied so as to reach the under surface of the leaves, and remain on them and not roll off.

6. The smallest amount of poison should be used to produce the desired result; much poison is wasted by persons who do not understand its proper application.

7. Remedies should be applied at the right time, usually *when the insect first appears;* as, for example, when a caterpillar has just hatched from the egg, or when a beetle begins to come out from winter retreats in search of food. Inex-

perienced persons apply for information after the principal damage is done, and before an answer in regard to remedial treatment can be received it is too late to apply remedies. In the treatment of insects which may always be expected, for example the striped cucumber beetle, preparation should be made *before* the appearance of the pest.

8. In the case of many insects it is usually necessary to apply remedies more than once, sometimes three or four times, according to the number of generations of the insects, and whether severe rains have intervened to wash away applications before the insects have fed upon them.

9. If injury is severe it is often desirable to apply remedies for other insects and diseases which may be present, as otherwise the crop may be ruined, though the primary cause be removed. Fertilizers are often advisable to stimulate plants and enable the production of a crop in spite of insect injury.

10. Clean methods of farming are of more value in preventing injury than any other method that can be named, and if it were more generally observed insect injury would soon be very materially reduced.

11. The cooperation of one's immediate neighbors is very desirable in the treatment of many insects, particularly those which are not free-flying.

12. The timely application of a remedy acts as a ***preventive.***

CHAPTER V

GENERAL CROP PESTS

INJURIOUS insects may be classified, as regards the nature of their food plants, into several more or less distinct groups.

The most important of these are choice or special feeders, and include many of our worst pests. They attack only single crops or crops of a single class, save in the direst necessity when they sometimes resort to other crops and weeds. Examples of this group are the two asparagus beetles which live exclusively on asparagus, the cotton worm and boll weevil, which are injurious only to cotton, and the tobacco worms which affect only tobacco, tomato and plants of the same botanical family.

Many insects are more or less nearly omnivorous. Although some have favorite host plants, they are likely to attack many other plants, and when extremely numerous or when the favored food becomes scarce they devour nearly every form of vegetation that grows in the garden, field, orchard or forest. This group is not so numerous as the first and not so destructive, as a rule, because of attack being distributed, but certain cutworms and other caterpillars, leaf-beetles, flea-beetles, aphides and others may do very serious damage, while still others, like locusts and army worms, sweep over large areas and in a short time ruin entire crops.

CUTWORMS AND RELATED INSECTS

Cutworms are among the most troublesome insects with which the market gardener has to deal. They are familiar to most persons, and sooner or later everyone engaged in plant growing has to contend with these pests, for they are what are termed

"general feeders," and able to eke out a living wherever they may be. Thus it happens that they are to be found in most gardens and nearly everywhere else, in pasture land, vineyards, fields and orchards, and even in greenhouses.

The species are very numerous, and many of them, like white grubs and wireworms, were the original inhabitants of the soil of this country, but some have been supplanted in injuriousness by species introduced from abroad. Taken as a class, cutworms rank with such insects as the San Jose scale, Hessian fly, the chinch-bug, and others of our worst pests.

When conditions favor the multiplication of cutworms they will feed upon anything green and succulent, whether foliage, flowers, buds, fruit, stalks, tubers, or roots. Although nearly ubiquitous, they are more especially destructive in truck gardens, and young, tender plants when first set out, such as tomatoes, cabbage, and plants just appearing above the soil, such as potatoes and corn, suffer most seriously. Several are destructive to foliage of fruit trees, and from their habit of climbing, are known as climbing cutworms; while in years of unusual abundance, some assume the army worm habit.

Cutworms are the progeny of owlet moths (fig. 27, *c*), and are nocturnal, remaining hidden during the day to come forth at night, the moths to mate and deposit their eggs, the cutworms to feast upon whatever happens to be most available and palatable.

There are so many species of injurious cutworms—between two or three score—that it is impossible to give a description that would fit all, but most common species are robust, soft-bodied, smooth or nearly smooth, cylindrical caterpillars, varying in color from pale whitish or dirty gray (like fig. 28, *a*), to nearly black, many being more or less plainly striped or spotted, as is the case with the w-marked cutworm shown in figure 25.

They seldom attract attention except in early spring, and then experienced persons can only too readily detect their

presence by finding young plants with tender stems that have just been set out, cut off near the surface of the ground. The culprit rests in a curved position during the day concealed in the earth around the plants which it has destroyed during the previous night. Some species leave open holes where they have buried themselves in the earth, others seek shelter under any debris, such as old boards, stones or dead leaves, and a few species have a habit of dragging portions of plants which they have cut off to their subterranean retreats where they can feed at leisure.

Fig. 25.—W-marked cutworm (*Noctua clandestina*) (After Riley)

Most species are single-brooded northward, but many produce two or more generations southward.

The greatest injury, as previously stated, is done in early spring for the following reasons: The last-appearing generation of moths issue from the ground in midsummer or autumn, and deposit eggs from which larvæ hatch and feed until cold weather drives them to their winter quarters. A considerable proportion of such larvæ are from half to three-quarters grown, and in this condition many hibernate, although a few species pass the winter in the pupal condition and less exceptionally as moths. The eggs are deposited, often in large masses, on such growth, grasses and weeds as spring up after a crop has been harvested, and when this is plowed under to make room for the new crop that is planted in spring, comparatively few plants come up, and as a result, the immature cutworms are forced to feed upon whatever is available. This explains their great destructiveness, as it is a matter of yearly occurrence in many neighborhoods for cutworms to destroy large portions of a planting and even entire crops, necessitating replanting sometimes a third or fourth time before a good stand can be obtained.

The life histories of cutworms vary according to the species

and the locality which each inhabits; hence little that is really typical of the group can be spoken of in general terms. After cutworms have accomplished their customary injuries in the spring and have attained full growth, they enter the earth, and many species remain in little, rather compact earthen cells (fig. 26) for several weeks or even months before assuming the pupal stage, which is of variable duration in the summer, from three to six or more weeks before the moths issue to perform the functions of their nature.

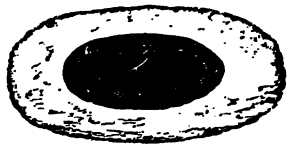

Fig. 26.—Pupa of cutworm in earthen cell. (After Riley)

The Greasy Cutworm (*Agrotis ypsilon* Rott.) is typical as regards its general appearance and is abundant in most localities suitable to it. It is one of our larger species, measuring when

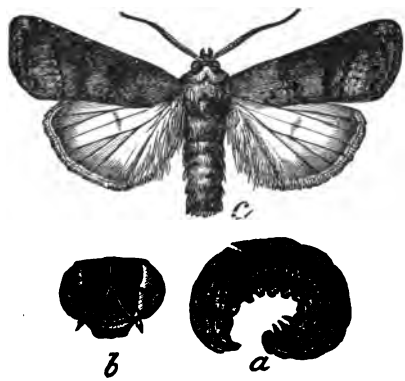

Fig. 27.—Greasy cutworm. *a*, Larva; *b*, head of same; *c*, moth. Natural size. (After Riley & Howard, U. S. Dept. Agr.)

mature about one inch and three-fourths. It is of the dull, dirty brown color, characteristic of so many cutworms, with the lower surface paler and greenish. The moth (fig. 27, *c*) has brown fore-wings marked with darker brown, more or less like

the specimen figured, and with an average expanse of an inch and three-fourths. It is a cosmopolite. This cutworm has a most pernicious cutting habit. It will sever large tomato plants over six inches in height generally at an inch above ground, and after destroying one plant it travels to others and thus in a night a single worm ruins three or four plants. It shows

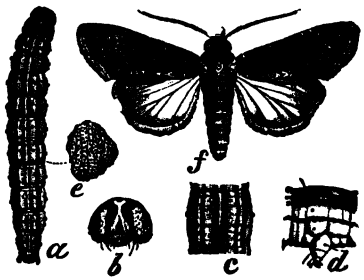

Fig. 28.—Granulated cutworm. *a*, Larva; *f*, moth Natural size. (After Riley)

some partiality for cabbage which it frequently devours as fast as transplanted. Potato, corn, lettuce and tobacco are favored, while ornamental flowering plants are not exempt. Of many plants it eats leaves and roots. It is probable that this species is double-brooded or has a dual method of hibernation.

The Granulated Cutworm (*Feltia annexa* Treitsk.) (fig. 28) is brownish gray and similar to the greasy cutworm, but lacks the greasy appearance, and may be recognized by the character which has suggested its English name. The entire surface of the body, as viewed with a magnifier, is seen to be closely covered with very small, round, blackish granules, each bearing a minute sharp point. The length, when full grown, is about an inch and one-half.

The Variegated Cutworm (*Peridroma saucia* Hub.).—This is with little doubt the most destructive and widely known of all cutworms. It occurs nearly everywhere and although, like others of its kind, it appears to favor garden plants, it will

attack nearly any form of vegetation, feeding on all parts of plants when it occurs in numbers. It is a climbing cutworm, and when exceptionally abundant, assumes the army worm habit. Its progenitor is a large moth (fig. 29, *a*) with pale, grayish-brown fore-wings tinged with reddish and shaded with

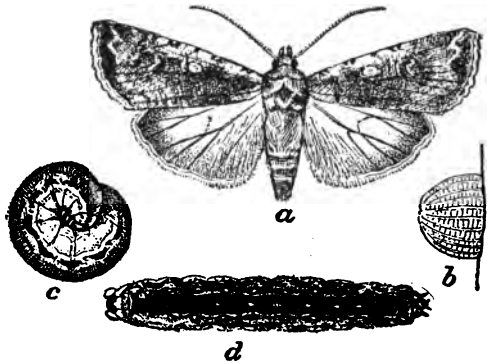

Fig. 29.—Variegated cutworm (*Peridroma saucia*). *a*, Moth; *b*, larva, lateral view; *c*, same coiled up; *d*, dark form, dorsal view. (After Howard, U. S. Dept. Agr.)

darker brown. There is considerable variability in markings, which are often suffused. The same holds of the cutworm itself (fig. 29, *c, d*). At maturity this cutworm measures about one and three-fourths inches. The variegated cutworm is cosmopolitan in the broadest sense of the word, and is injurious throughout practically all arable regions.

METHODS OF CONTROL

Poisoned baits are the standard remedies against cutworms. To be effective they should be applied as soon as attack is noticed and are particularly valuable in cases where the direct application of poisons is impossible owing to the danger of poisoning persons or stock when it is used for food. There are two kinds of bait—fresh vegetable and bran mash.

Vegetable bait.—Vegetable bait may be prepared by spraying

a patch of clover, or useless succulent plant with Paris green, 1 pound to 150 gallons of water; mowing it close to the ground, and placing it while fresh in small heaps about infested plants at intervals of a few feet. Owing to the wilting of this bait, in dry, sunny weather, it is advisable to cover each heap with a chip, shingle, or something similar.

Bran mash or bran-arsenic mash is, according to some, still more efficacious. Paris green, white arsenic, or other arsenical can be used for poisoning, and in its preparation, on account of the weight of the poison and the fact that it soon sinks when stirred, it is best first to mix the bran with water and sugar and then add the poison. The proportions are 2 or 3 ounces of sugar or a similar quantity of glucose or molasses to a gallon of water and sufficient bran (about a pound per gallon) to make, when stirred, a mixture that will readily run through the fingers. Before planting a crop it is advisable to use bait, and for perfect success the ground should be bare, which will have the effect of practically compelling the cutworms to feed on it.

Protection of plants that are set out, such as tomato and cabbage, started under glass, may be secured by placing about the base of each a tablespoonful of poisoned bran or a small bunch of the poisoned vegetable. Sometimes it is feasible to dip plants like tomato and sweet potato in poison before setting out. Arsenate of lead is best for this purpose prepared as for spraying 1 pound to 25—50 gallons of water. Where it is possible, however, to spray grass or weeds which have grown up in fields about to be cultivated, this should be done, as it is an easy means for riddance of cutworms and less troublesome than the preparation and distribution of baits. Plants may also be protected by paper wrappings and tin collars.

Bordeaux mixture has been tested against the variegated cutworm upon potato vines and asparagus. It was sprayed on as a remedy for blight, and it was discovered that plants thus treated were free from attack. The use of this fungicide as a

cutworm deterrent is certainly advisable. In any case, it should be employed as a diluent for whatever arsenical is used.

Hand methods.—On some plants it is next to impossible to apply any but hand methods with good results. Experiments in Washington State during 1900 demonstrated conclusively that in some cases it required less time to shake or brush the variegated cutworm from affected plants than to destroy them by spraying or otherwise.

In ordinary cases of cutworms in greenhouses they can be held in check by hand-picking. It is the custom of some florists to hunt for them at night with a lantern, when they are feeding and can readily be discovered and destroyed.

Treatment as an army worm.—When cutworms assume the habit of traveling in armies they should be treated in the same manner as advised against the fall army worm in pages which will follow.

The Fall Army Worm (*Laphygma frugiperda* S. & A.).—The fall army worm or grass-worm feeds normally on grasses and grains and weeds belonging to the grass family, but will attack in its seasons of abundance almost any form of vegetation that is encountered in its line of march. At such times it becomes a pest in garden and orchard, on lawns and in greenhouses, as well as in pastures and in fields of grain. The moth is quite unlike that of the common army worm and very variable, there usually being two distinct forms, a dull gray and an ornamented form (fig. 30, *a* and *b*). The hind-wings are glistening white with rosy reflections. The wing expanse is from an inch to an inch and three-eighths. The eggs are deposited in clusters of from fifty or more, often in two or three layers. The mass is covered with down from the body of the moth. The differences between this and the true army worm are shown by figures 30, *a*, 30*x* and 31.

This insect is undoubtedly native to North as well as South America. Its greater abundance in semitropical regions indicates that it was originally, although not in very recent times,

tropical. At present it is more at home in the South where opportunity is afforded for its increase in swamp land, among wild rice and rank grasses, but it is also acclimatized in the southern portions of the North and appears to be gradually working its way still farther northward.

Injury has been noted as far north as Chicago and westward to Colorado and Montana.

A feature of this insect's attack, from which it derives its name of fall army worm, is that it seldom does appreciable in-

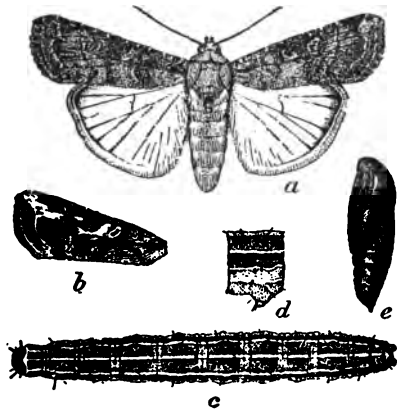

Fig. 30.—Fall army worm. *a*, Moth, plain gray form; *b*, fore-wing of Prodenia-like form; *c*, larva; *d*, abdominal segment of larva; *e*, pupa. *d*, Twice natural size; others enlarged one-fourth. (Author's illustration, U. S. Dept. Agr.)

Fig. 30x.—*a*, Head of fall army worm; *b*, of army worm. Both enlarged.

jury except in the fall. It is not often noticed, therefore, except in the extreme South, earlier than the first of August, while the outbreaks of the common army worm usually occur prior to that time.

There is no doubt that there are two or three generations produced each year, and each succeeding generation usually becomes more destructive. It attacks practically all vegetables.

The larvæ, in years of ordinary abundance, live like cutworms

and are so dark and evidently secretive in their nature as to usually escape recognition. When, however, an undue increase in numbers takes place and the habit of moving in armies is assumed, their presence becomes manifest, too late, however, in most instances, for remedial treatment. Transformation to pupa takes place in little earthen cells, but occasionally pupæ are not so protected.

METHODS OF CONTROL.—In the case of large armies in extensive fields, poisons are of little value when outbreaks are at their height. When the armies are first noticed the "worms" are as a rule approaching maturity, they have effected much damage, and it is difficult at this stage to prevent them from passing from one field or other tract to another. It follows that, although arsenical poisons are valuable in many cases, we must place more reliance in preventives such as cultural and mechanical methods.

In fields of young grain and on lawns many "worms" may be killed by crushing with a heavy roller, when the insects are at work early in the morning or toward dusk. In fields that are injured beyond recovery, sheep or other cattle may be turned in in numbers with benefit, as they will kill the larvæ by trampling upon them.

Other useful methods of this nature include trenching or ditching, or plowing deep furrows in advance of the traveling hosts to entrap the larvæ which will fall into them, and here they may be crushed by dragging logs or pieces of brush through the furrows. If possible to fill the trenches with water, or if they become partially filled by rains, the addition of a small quantity of kerosene, so as to form a thin scum over the surface of the water, will prove fatal to the "worms."

Rotation of crops should always be practiced, as well as burning over fields when they are too badly infested to recover. Above all other precautions necessary to secure immunity from attack is that of keeping the fields free from volunteer grain

and wild grasses, since experience shows that these are the favorite breeding grounds of the insect; when the larvæ hatching from these eggs have devoured the grain and grasses they are driven to cultivated fields for food.

Fall plowing and disking should always be practiced where circumstances will permit.

The Army Worm (*Heliophila* [*Leucania*] *unipuncta* Haw.).—The true army worm is so well known as a grain and grass pest that a short account only need be given, more particularly since it seldom injures vegetables other than corn. Its general economy closely resembles that of the fall army worm, previously treated. The army worm proper (fig. 31) is larger, a little stouter, more distinctly striped and much smoother than the fall army worm, measuring about an inch and a fourth in length. The parent army worm is a pale yellowish brown moth with a white spot near the center of each fore-wing. This insect appears much earlier in the year than the fall species. From May to July it accomplishes its greatest injury; and although nocturnal by nature, when conditions favor its increase it soon exhausts its food supply, crowds then gather and march in armies—the habit from which it has received its name—in the heat of the day as well as at night. Winter is passed usually in the partially grown caterpillar state in the same manner as with cutworms. Injury may be accomplished by any generation, but is most often due to the second brood.

Fig. 31.—Army worm. About one-third enlarged.

REMEDIES are practically the same as advised for the fall army worm.

MISCELLANEOUS CATERPILLARS

Caterpillars of omnivorous habits other than cutworms and webworms may be divided into two groups—naked and hairy caterpillars. Both forms are in the main diurnal, at least during their early stages, but some naked species as they approach maturity crawl into shelter where they are more or less protected from the sun's rays as well as from natural enemies. The

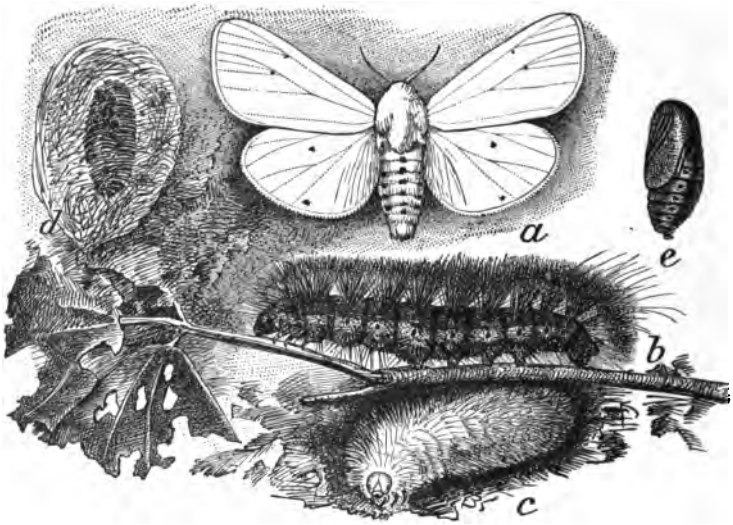

Fig. 32.—Yellow bear. *a*, Female moth; *b*, full-grown larva; *c*, light form of larva, not quite mature; *d*, cocoon; *e*, pupa. All slightly enlarged. (Author's illustration, U. S. Dept. Agr.)

naked caterpillars are more abundant and injurious, and include such species as the zebra and clover caterpillars and corn-ear worm. Among the hairy caterpillars are such well-known forms as the yellow bear (*Diacrisia virginica,* figure 32), salt-marsh and hedgehog caterpillars and smeared dagger. Most hairy caterpillars are rather more abundant on useless plants than on crops, a fortunate thing for the grower.

Garden Webworm (*Loxostege similalis* Gn.).—This species affords an excellent example of an insect that feeds normally on weeds and only in times of abundance becomes a pest and general feeder. In such times it will attack most vegetables. In 1885 a serious outbreak occurred over a large area in Kansas, Nebraska, Missouri, Arkansas, Texas, and in what was then known as Indian Territory. Corn suffered most and a replanting

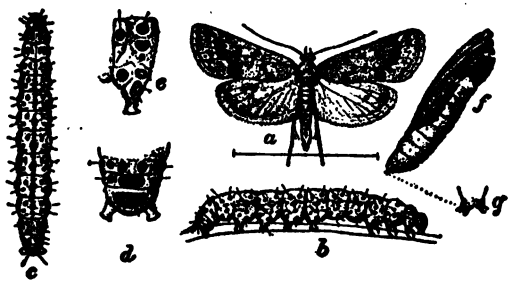

Fig. 33.—Garden webworm. *a*, Male moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, anal segment; *e*, abdominal segment, lateral view; *f*, pupa; *g*, cremaster. (After Riley, except *c*, Chittenden, U. S. Dept. Agr.)

was necessary in several instances, and the yield per acre was much reduced, owing largely to the ravages of this webworm.

The moth (fig. 33, *a*) is variable, yellow, buff, or reddish-brown. It has an expanse of wing of about three-quarters of an inch. The larva (*b, c*) varies also, the ground colors running through pale and greenish yellow to dark yellow. It is strongly marked with black, piliferous spots (*d, e*).

The garden webworm occurs generally throughout the United States and is most injurious in the South. Its favored natural food plant is "careless" weed (Amaranthus). The caterpillar, soon after hatching, draws together the edges of a leaf by means of its web, or fastens together two contiguous leaves, forming a shelter, from which it crawls forth to feed.

Remedies.—A spray of Paris green has been used with perfect satisfaction against this webworm, the fact that it is more

or less surrounded by webs and leaftissues offering little or no barrier to the effects of the poison. In addition, clean cultural methods, including late plowing in the fall followed by deep plowing in spring, and the burning of all waste material and weeds, are of service in controlling this pest. Early planting is useful as a safeguard for some crops.

LEAF-BEETLES

Leaf-beetles (*Chrysomelidæ*) are among the most important groups of insects, economically speaking. Many of them select in the larval stage single species or plants of the same or similar botanical families, but the beetles are more inclined to be omnivorous, and some devour nearly all forms of vegetation. Their larval habits are variable, but a considerable proportion subsist on plant tissue on the external surface of leaves. A smaller number develop in mines which they construct in the leaves or in the roots, in fruits and seeds, and even in flower heads and in stems. A familiar example of a leaf-beetle larva that lives externally on leaves is the Colorado potato beetle, and of the root-feeders are the corn root-worms. An example of those which live in seeds is the twelve-spotted asparagus beetle. Such as feed on the outer surfaces of leaves are more or less grub-like, with six true legs and a proleg at the posterior extremity. Their colors are often well marked, red or yellow, with rows of black spots as in the case of the Colorado potato beetle. The root-feeders, however, are pale, frequently white and elongate, even threadlike in form.

The greatest amount of injury is generally due to the hibernated beetles on young and tender plants before they have made good growth. Some species, indeed, cause little trouble after this period, while others, like the Colorado beetle, occasion losses of greater or less extent throughout the growing season of the plants which they affect.

Our most common omnivorous leaf-beetle is the twelve-

spotted cucumber beetle (fig. 3), the parent of the southern corn root-worm. It will be considered more at length in the chapter on corn insects.

FLEA-BEETLES

Flea-beetles (*Halticini*) constitute a sub-family of the leaf-beetles. They are of elongate oval form and similar color, frequently striped like the cucumber beetle, and may be distinguished by their enormously developed hind thighs, which furnish them with powerful leaping ability. The most injurious forms are minute and dark-colored. Their habit of suddenly hopping from the vegetable on which they are feeding has given them the common name of flea-beetles or fleas, some species being known as "potato flea," "cabbage flea," etc., according to the plant infested. Many flea-beetles are general feeders, and nearly all are subject to a periodicity, dependent on factors with which we are little acquainted, but doubtless in large part traceable to atmospheric conditions, moist weather furnishing the best conditions for the development of the young or larvæ, and dry weather being inimical to their increase, this hypothesis being based upon the knowledge that the larvæ of many species are subterranean.

Injury is frequently very severe on young plants and is due in the greatest measure to the ravages of the adult flea-beetles which frequently appear in prodigious numbers in cultivated fields and like a pestilence sweep everything before them, their depredations often necessitating the replanting of entire crops.

The larvæ of most flea-beetles develop in weeds, a comparatively small proportion living on cultivated crops. Knowledge of this fact is of value in indicating methods of control.

The Pale-striped Flea-beetle (*Systena blanda* Mels.) is a destructive vegetable-feeding species. It measures about an eighth of an inch, is cream-colored, with nearly black abdomen and eyes, and the wing-covers are ornamented with a bright sutural and two narrower marginal stripes of dull light brown (fig. 34, *b*). The larva is white and slender, with light brownish-

yellow head. The legs end in blunt padlike processes. It is an American species and of rather wide distribution, from New Jersey southward to Georgia and westward to California. The beetle is nearly omnivorous and injurious to beans, beets, potatoes, tomatoes, eggplant, corn, carrot, melon and other cucurbits, turnip and other crucifers. It also attacks strawberry, cotton, oats, peanuts and the leaves of pear. The beetles sometimes do severe damage in three or four days. The species hibernates as a beetle, and appears in the vicinity of the District

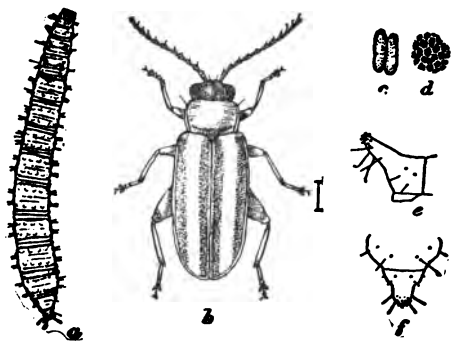

Fig 34 —Pale-striped flea-beetle. *a*, Larva; *b*, beetle; *c*, eggs; *d*, sculpture of egg; *e*, anal segment, from side; *f*, same from above. *a-d*, six times natural size; *e*, *f*, much enlarged. (Author's illustration, U. S. Dept. Agr.)

of Columbia early in June; egg laying continues to the middle of July, if not later; injury is usually due to the beetles upon their first appearance and almost any valuable crop may be injured. The larvæ live below the ground, and have been observed by the writer and others feeding on roots of corn, lamb's-quarters and Jamestown weed.

The Banded Flea-beetle (*Systena tæniata* Say).—The banded flea-beetle has similar habits to the preceding and similar structure; it was in fact, until quite recently very generally confused with the pale-striped form, and many references to injuries by it are really due to the latter. Like the latter it varies con-

siderably. It is polished black with white stripes. A common dark form is shown in figure 35.

METHODS OF CONTROL

Arsenicals and Bordeaux mixture.—The best remedies for leaf-beetles and flea-beetles are Paris green or other arsenical and Bordeaux mixture, either in combination or separately. Bordeaux mixture alone acts as a deterrent, and the writer suggests that instead of using either one separately, or both in combination, that the greater portion of an infested field or garden be sprayed with the Bordeaux mixture freely and as often as may be necessary, particularly after heavy rains, while strips here and there be sprayed exclusively with Paris green. This will have the effect of driving the beetles from the Bordeaux-sprayed plants to the poisoned ones. Paris green alone, dusted dry on infested plants, is thoroughly effective against many species. Arsenate of lead is preferable for spraying tender plants like beans, whose foliage is liable to scorching. Plants like tomato, eggplant, and cabbage that are started under glass and that are liable to flea-beetle attack, should be dipped in a solution of Bordeaux mixture and Paris green or lead arsenate before transplanting. For direction see page 55.

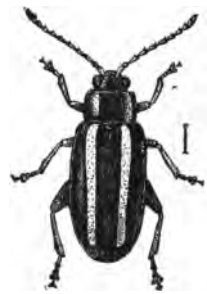

Fig. 35.—Banded flea-beetle, dark variety. (Author's illustration, U. S. Dept. Agr.)

Kerosene emulsion and soap washes, even strong soap-suds, have been used with profit in combating some flea-beetles.

Pyrethrum, dry, mixed with flour or road dust, may be employed for small gardens.

Cultural methods.—In the protection of young plants knowledge of the fact that the larvæ of many species subsist by preference on weeds must be remembered, and the grower should, moreover, familiarize himself with the particular natural

or wild food of the beetles which injure his crops. Thus nightshade and Jamestown weed harbor the larvæ of the Colorado beetle and flea-beetles which attack potato and eggplant, and it is therefore imprudent to plant crops in fields which have produced such weeds. Injury to corn by corn root-worms is in many cases directly traceable to planting in corn land, and flea-beetle damage to corn follows when this crop is grown in soil previously in grasses which furnish food for their larvæ. In the same manner leaf-beetles and flea-beetles which attack beans and beets, breed in such common weeds as lamb's-quarters.

At the same time that beetles are ravaging our crops, they may also occur on nearby weeds, and for thorough work the insects should be destroyed by poisons or other means on the wild as well as the cultivated plants.

Poultry and toads are fond of leaf and flea-beetles, and it is recommended to encourage these valuable aids to the farmer, by placing coops of chickens or other young fowl in vegetable gardens and to protect the toads.

BLISTER BEETLES

Many species of blister beetles (*Meloidæ*) are very destructive to vegetables, particularly in the Southwest, and especially to potatoes and beets, beans, peas, and other leguminous crops. They are gregarious and in their season habitually congregate in great numbers. Some have the migratory habit, feeding voraciously, running with great rapidity, and flying from time to time. Thus it happens that they frequently descend in such numbers on a field that a crop is ruined in a few days, when the insects go elsewhere or disappear and are perhaps seen no more until the following year. After the departure of one species of blister beetle another frequently follows, to be replaced sometimes by a third. Blister beetles are not an unmixed evil, however, since they do some good in their larval stage to compensate for the harm the beetles occasion to our crops.

Their larvæ destroy grasshopper eggs and thus aid in keeping these pernicious insects in check. This is especially true where both blister beetles and grasshoppers abound. But the benefits derived are really more than counterbalanced by the losses occasioned by the rapacity of the beetles; hence measures should be employed to destroy them when they occur in harmful numbers. Blister beetles are apt to be found in practically all vegetable fields.

The Striped Blister Beetle (*Epicauta vittata* Fab.).—Before the advent of the Colorado beetle this was considered the most

Fig. 36.—Striped blister beetle (*Epicauta vittata*). Female beetle. (Author's illustration, U. S. Dept. Agr.)

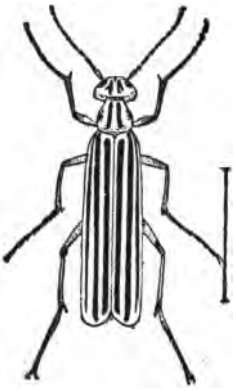

Fig. 37.—Three-lined blister beetle (*Epicauta lemniscata*). (Author's illustration, U. S. Dept. Agr.)

destructive potato pest of the East and, probably because it is striped somewhat like the latter, it is more often called "old-fashioned potato bug" than other species. It can be easily identified by means of the illustration (fig. 36). Although much attached to the potato, this species also does injury to beets, beans, peas, tomatoes, radishes, and melons.

The Three-lined Blister Beetle (*Epicauta lemniscata* Fab.).—This blister beetle very closely resembles the preceding; in fact,

the two are frequently confounded, and injuries inflicted by one attributed to the other. The form under consideration (fig. 37) is a little more slender, has three stripes on each wing-cover instead of two, and is a little longer. It is very abundant southward, and is partial to potato, cabbage, squash, and to beet tops.

The Spotted Blister Beetle (*Epicauta maculata* Say).—The southwestern portion of the United States is the home of many species of blister beetles not found in the north and east. Among the most abundant is the species illustrated in figure 38. Its body is covered with fine gray hairs, with small areas on the elytra, through which the natural black of the body shows, giving it the appearance of a gray insect finely dotted with black. It abounds from Texas and New Mexico northward to South Dakota, thence westward to California and Oregon. It is found upon potato, beet, clover and other plants.

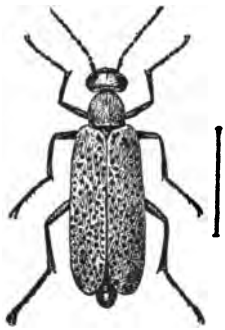

Fig. 38.—Spotted blister beetle. (Author's illustration, U. S. Dept. Agr.)

REMEDIES.—Paris green is one of the best remedies for blister beetles when they occur on potatoes and most other crops. It may be applied dry, or as a spray, according to directions already given in the discussion of insecticides. Arsenate of lead is also excellent for these pests. Repeated applications are sometimes necessary, since the poisoned beetles are replaced by others. A remedy employed with success in the West consists in sending a line of men and boys through infested fields to drive the beetles, by short flights and running, before them until they alight in windrows of hay, straw, or other dry vegetable material which have previously been prepared along the leeward side of the field. When the beetles have taken refuge in such a windrow, it is fired and the beetles

are burned. Whatever remedy is employed should be applied at the outset of attack in order to be of substantial value.

GRASSHOPPERS AND RELATED INSECTS

Of great importance in the West, and in some seasons in other regions, are numerous species of locusts, or short-horned grasshoppers. Several related insects, such as katydids and crickets, are also injurious. All of these are general feeders, and as a rule destructive to vegetable crops only in seasons which have been particularly favorable to their multiplication. The numbers of species of these insects mount into the hundreds, but the most important forms might be reduced to a double score.

For present purposes it will be necessary to mention only a few of the most abundant forms. Grasshoppers are mostly large insects, with mouth-parts formed for biting, with young more or less closely resembling the adults, save for the lack of wings. Their name is sufficient indication of their habits: they live normally in grasses, and their hind thighs are enlarged for leaping. Everyone knows them so well that further description is unnecessary. Some species are capable of extended flight for hundreds of miles with intermissions of daily stops for food. At such times they occur in swarms, and sometimes darken the face of the sun, or at night of the moon.

Grasshoppers may be classified in regard to their habits as *non-migratory* and *migratory*. In the latter group are our commonest species which breed and pass their entire lives in or near the place where the eggs were laid from which they develop. The migratory species develop in enormous numbers, and when they become too abundant for the food supply of the region where they originated they migrate. They are most troublesome in arid and semi-desert regions, and their numbers are subject to variation according to climatic conditions and locality. Dry regions are liable to the visitation of a locust

swarm at any time of the year, and they are the most dreaded of pests, because of the rapidity of their attack, when they lay waste large districts, and even considerable portions of states.

The Red-legged Locust (*Melanoplus femur-rubrum* DeG.).—This is our commonest North American grasshopper, being found practically everywhere. It is one of the smaller species (fig. 39), and where it is not held in subjection by natural enemies it may become a decided nuisance in cultivated lands. It seldom exhibits the migratory tendency, but sometimes gathers in swarms and moves in concert, not, however, rising to great heights, but drifting with the wind as do the true migratory species.

Fig 39.—*Melanoplus femur-rubrum* Natural size. (After Riley)

The Rocky Mountain Locust (*Melanoplus spretus* Thomas).—This is the most destructive of all native grasshoppers, and has been the cause of greater losses to agriculture in the past than perhaps all of the other known species of grasshoppers

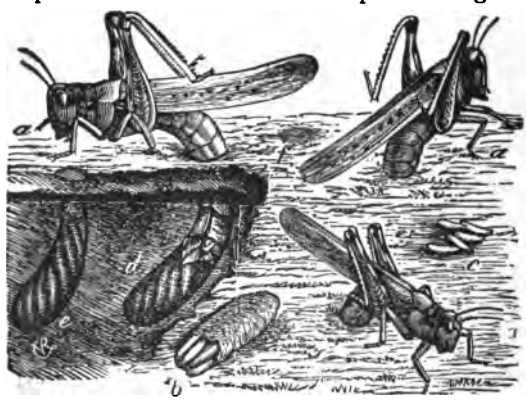

Fig. 40.—Rocky Mountain locust. *a*, *a*, *a*, Female ovipositing: *b*, egg-pod extracted from ground, with end broken open; *c*, a few eggs lying loose on ground; *d*, *e*, earth removed, to illustrate egg-mass in place and one being placed; *f*, where a mass has been covered up. (After Riley).

combined. Its range of injuriousness is not limited to the Rocky Mountain region, but it is more abundant there than elsewhere. It is illustrated in figure 40. Those who were interested in farming in the 70's in Kansas, Nebraska, and some neighboring states have cause to remember the depredations of the Rocky Mountain locust. During 1874-1877 it was directly responsible for the loss of $100,000,000, in addition to an indirect loss by the stoppage of business and other enterprises which might have aggregated as much more. It was for an investigation of this species that the United States Entomological Commission was formed, which published from 1877 to 1879 two voluminous reports on it alone.

The Differential Locust (*Melanoplus differentialis* Thomas).—In the Middle West the farmer is much bothered at times by

Fig. 41.—*Melanoplus differentialis*. Natural size (After Riley)

the large yellow locust, shown in figure 41. It is found along roadsides and on the edges of groves, preferring rank vegetation where such abounds. When it becomes unusually numerous it is quite destructive to vegetable crops and to cereals.

METHODS OF CONTROL

Locusts or grasshoppers are largely kept within normal numbers by numerous enemies, among which are many large forms of insectivorous birds and mammals, batrachians and reptiles. They also have large numbers of predaceous and parasitic insect enemies, which kill them off in ordinary seasons. With changes of the weather, however, the insect enemies are frequently destroyed, and then the locusts become abundant. In such cases

the grasshoppers can be controlled by several artificial methods. The remedies that have proved most efficient are plowing under the eggs before these have had time to hatch, and the capture by means of hopper-dozers of the unfledged locusts, as well as many of those which have become winged. These are shallow sheet-iron pans in which are placed tar or coal-oil tar or kerosene oil, and which may be drawn or pushed by hand over the ground or by horses, in such a manner that the hoppers will leap into the pans and be killed by coming into contact with the tar or oil. Hopper-dozers are shown in figures 21*y* and 21*z*.

Other remedies of great value in the prevention of injury to our cultivated crops are the bran-arsenic mixture and poisoned horse droppings. Directions for preparing the former have been given on page 54.

Poisoned horse droppings consist of 1 part of Paris green mixed thoroughly in 60 parts of fresh horse droppings, 2 pounds of salt to half a barrel of mixture being added after being dissolved in water. This is placed in half barrels and drawn on carts to the edge of the infested field or one likely to be invaded. The mixture is then scattered broadcast along the edge of the crop, or wherever needed, by means of a trowel or wooden paddle. The locusts are attracted to it and are killed in large numbers by eating the poison. Although this mixture is "sure death," it sometimes requires from two to five days for it to kill the locusts.

Turkeys are of great value in freeing orchards and vineyards of locusts, and they may be employed in other fields for the same purpose. In one case a flock of 766 turkeys were kept at work in the destruction of grasshoppers. The turkeys have to be watched, as they sometimes vary their diet with vegetables.

In some cases it has been possible to ascertain the particular breeding places of grasshoppers, some species depositing their eggs in pasture lands and among foothills at the bases of mountains in the Far West, in regions in which the tar weed

grows. Here the eggs can be destroyed by burning over the ground late in the fall after all of the eggs are deposited, or by plowing them in to a depth of six or eight inches before they hatch in the spring.

In case it is for any reason not feasible to employ any of these last mentioned remedies, and the place of egg deposit is ascertained, a watch should be kept for the young grasshoppers, and they should be destroyed as soon as possible after hatching by means of bran-arsenic mash.

Cooperation is greatly desirable in the treatment of grasshoppers, particularly in regions where they reach their greatest development; and the thoroughness with which work is done in one year will show the next season in the greatly reduced numbers with which the farmers will have to deal.

Remedies for grasshoppers in general are applicable to the migratory species, but the latter sometimes occur in such immense swarms that it is difficult to treat them. It is of the highest importance that whatever remedies are employed must be used at the very first onset and generally over considerable territory, as the insects fly from one field to another.

WHITE GRUBS

White grubs occupy a prominent position among the many insect foes to agriculture. There are several hundred distinct forms of these creatures, each representing a different species of the family Scarabaeidæ. A considerable number are of prime importance economically, the remainder are less injurious or do not attack useful plants. The noxious forms subsist on roots and are very abundant under sod, and in similar locations. Of these a considerable majority of the typical white grubs belong to the genus Lachnosterna, of which nearly a hundred species are known.

The parents of white grubs are known as May beetles or "May bugs" in the South and Middle states, and as June beetles

or "June bugs" in the North, from their occurrence in numbers in these months in these different regions. Injury is by no means confined to the white grubs, but can often be laid to the account of the beetles, but the latter are most destructive to shade and fruit trees.

White grubs or "grub-worms," with wireworms and cutworms were the original inhabitants of the soil before the advent of civilized man. They lived in our open prairies when America was still a wilderness, and they continue to dwell in our grass lands, meadows, fields and gardens and repel all attempts toward their permanent removal. The farmer who imprudently plants corn or potatoes in fields that have long laid waste and become grown up with weeds and grasses, or where strawberries have been the previous season, does so at the risk of losing his crop. The problem of how to destroy them and to protect the crops from their ravages is a subject requiring constant and scientific treatment. Injury appears to be most noticeable to corn, grasses, small grains, beets, potatoes and other root crops, and strawberries, but the roots of young shade, fruit and forest trees are also attacked.

As with insects of similar habits, white grubs and May beetles are liable to considerable fluctuation of numbers in different localities and years. This is most noticeable after crop rotation, particularly, as might be inferred from what has already been said, where susceptible crops are planted in grass lands. Attack may commence from the time the plant sends out roots, and continue for a much longer time, as these insects pass two or three years from the egg until they reach the adult condition. When the larvæ are present in great numbers at the roots, the plants soon die and whole crops are ruined.

In a general way white grubs may be described as large, soft white or yellowish grubs, with wrinkled bodies, sparsely covered with fine hairs, having yellowish or brownish heads with strong mandibles, three pairs of distinct legs on the fore part of the

body (the three thoracic segments) and the hinder portion of the body considerably thickened toward the end. The normal position of typical white grubs is curved, as shown in figure 42, *e*. They crawl on their sides, not on their backs as is the case with the non-injurious white grub of the June beetle.

The parents of the injurious or typical white grubs (*Lach-*

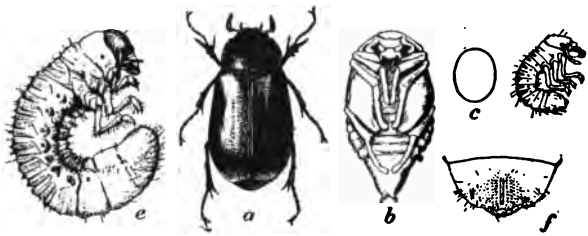

Fig. 42.—Arcuate May beetle. *a*, Beetle; *b*, pupa; *c*, egg; *d*, newly-hatched larva; *e*, mature larva; *f*, anal segment of same. (Author's illustration, U. S. Dept. Agr.)

nosterna spp.) are for the most part large, shining brown beetles, known to every one from their habit of flying into lighted rooms through open windows, in late spring and early summer, buzzing and bumping upon the ceilings and walls and finally falling to the floor. A comparatively small number are yellowish, or plum color, and some few are nearly black.

From April to July, according to climate, these beetles appear, often in great numbers, about our electric lights and upon our fruit and shade trees, their appearance each day beginning almost uniformly at sundown. They feed voraciously upon the leaves of trees, and bushes such as blackberry, but are especially fond of the foliage of nursery stock and other young trees, particularly oak, chestnut, hickory, maple, and fruit trees, often doing such damage to newly transplanted shade and orchard trees as to result in their complete defoliation and destruction. The beetles fly and feed only at night, and during the day remain perfectly quiet in the vicinity of their feeding places. It has lately been shown conclusively (what was previously in-

ferred by deduction) that one species, *Lachnosterna arcuata*,[1] requires only a little over two years for larval development, but about three years are consumed from the time the egg is laid until the appearance of the beetle above the ground, and this is probably true of most of the species which occur in this country. Thirteen days was ascertained as the egg period, twenty-three for the pupa, and the total period from egg to adult required two years and fifty-one days.

The sexes pair soon after their first appearance and the females enter the earth for oviposition. The eggs, which are rather large and whitish or gray, are deposited singly in the ground. The grubs, hatching among the roots of grass and similar plants, feed at first upon the tender rootlets and afterward on the larger roots, and slowly increase in size until mature.

The species which have been observed usually transform to pupæ from the middle of June to September of the second or third year after hatching, and become fully-developed beetles in August or September of the same year. They remain in the earthen cells in which transformation has taken place, sometimes at a depth of from twelve to eighteen inches, where they are protected from cold and frost, and appear abroad the following spring to repeat the life cycle. Hibernation may occur in two stages of the larva, and occasionally in a third, and as beetles.

The Arcuate May Beetle (*Lachnosterna arcuata* Sm.) is the common May beetle of the Middle Atlantic region. The Northern June Beetle (*Lachnostera fusca* Fröhl.) is abundant in the Middle Atlantic region, and is quite as destructive and over a wider extent of territory. It is the common species from New England to Illinois, and occurs, but comparatively rarely, farther west. A large proportion of the injury caused by white grubs and June beetles in the region specified are due to this insect.

[1] See article by the writer, Bul. No. 19, Div. Ent., U. S. Dept. Agr., pp. 74-80.

The winged Northern forms of May beetles are replaced in Texas and some other portions of the South by three common species, two wingless (*Lachnosterna cribrosa* Lec. [fig. 43] and *L. lanceolata* Say) and one with similar habits (*L. farcta* Lec.) which do great damage in their beetle stage to trucking industries. They subsist largely upon weeds, hence in addition to treating affected plants with arsenicals, the weeds should be similarly treated. Late fall or winter plowing and avoidance of weedy fields for planting are advisable as preventives. Swine should be used for destroying them and on small areas hand-picking can be employed, when the beetles make their appearance an hour or more before sundown.

Fig. 43.—*Lachnosterna cribrosa*. Female. (Sanderson, U. S. Dept. Agr.)

Among white grubs that are likely to be mistaken for the more injurious forms (*Lachnosterna* spp.) are the carrot beetle, which will be considered in a later chapter; the "muck worm," which occurs in manure and in the droppings of cattle, and which appears to be normally a purely dung-feeding species; the sugar-cane beetle; the rice grub; the green June beetle, and the brown fruit-chafer, which last will be described in the consideration of insects affecting sweet corn.

PREDACEOUS AND PARASITIC ENEMIES

Although white grubs are apparently protected by their subterranean mode of existence and their life, as beetles, is comparatively brief, many predatory animals as well as parasitic and predaceous insects attack and destroy them. Birds of several species and most wild mammals which still linger in cultivated regions are among this number. Domestic fowls are very fond of white grubs and, when given the opportunity, fol-

low the plow for them. Swine also search out and eat many which they obtain by uprooting the turf.

Of the insect enemies of white grubs are Tachina flies, wasps

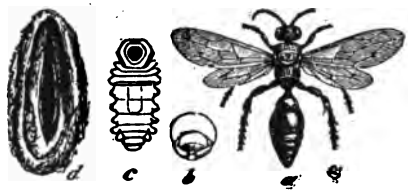

Fig. 44.—*Tiphia inornata*. Parasite of white grub. *a*, Female wasp; *b*, head of larva; *c*, larva from below; *d*, cocoon cut open. (After Riley)

and parasitic Hymenoptera, mites, and predaceous ants. Among these insects is the wasp, *Tiphia inornata* (fig. 44). Under certain conditions white grubs are also much subject to infection by fungous parasites.

REMEDIES FOR WHITE GRUBS

Insecticides.—Good results have followed the use of bisulphid of carbon and kerosene emulsion against some species. The emulsion is diluted about ten times and poured on the ground about the infested plants. Application is made just before rainfall, to insure the emulsion being washed deep into the soil so as to come into direct contact with the larvæ. If rain does not fall within a day or two a copious watering should follow the application. Gas lime is also valuable. (See page 34.)

Fall plowing is a most effective remedy. The land should be thoroughly broken, and loosened to expose the grubs and beetles to the elements during winter. This is particularly valuable in cold climates, as white grubs are unable to withstand exposure to severe frost. Cross-plowing is sometimes advisable where there is severe infestation. This will insure the ground being often disturbed, and, if kept clean of weeds and other vegetation, the grubs can be "wiped out."

Preventive measures are still more valuable. The best of

these consists in avoiding for the planting of vegetable crops land which is already known to contain white grubs and especially grasslands, whether meadow or prairie. Corn fields should not be planted to root crops and the like without rotation with clover or other immune crops. Summer fallowing of infested land is said to be useful.

Rotation of crops is valuable in connection with fall plowing. In case infested land is desired for the planting of corn, beets, potatoes, or other crop subject to severe injuries by white grubs, an application of fertilizer, such as nitrate of soda or kainit, put on as a heavy top dressing after the ground is prepared and before planting, has proved of benefit in some cases.

Domestic animals.—Much good may be accomplished by encouraging domestic fowls to follow in the furrows to pick up the grubs as they are turned up by the plow. Hogs are also exceedingly fond of white grubs, and if allowed the run of localities where these are abundant, after the crop is made, they will root up the ground and devour great numbers of them.

WIREWORMS

Of similar importance to white grubs as general farm pests are the wireworms. Though not related to the white grubs, they have very similar habits, the injurious vegetable-feeding forms being strictly subterranean and subsisting at the expense of various crops, especially corn, cereals, and grasses, but attacking, in the absence of these, various vegetables and other plants. The subject of soil and environment as regards attack by wireworms has not been thoroughly studied, but certain species are more numerous in sandy lands, and others are almost always found in unbroken prairies and in wild grasses. Thus it happens that, as in the case of white grubs, injury is most apt to occur when corn and other vegetables are planted in old sod, along the borders of marshes, in pastures and meadows.

Nearly every tiller of the soil is familiar with wireworms,

and there are many species, but, fortunately, a small percentage only of nearly 600 described forms have been identified in connection with losses. From an agricultural viewpoint they fall into two classes, such as feed upon living vegetation, and those which subsist upon rotten wood and similar material. Most of the noxious forms that have been recognized are wire-like, hence the common name, and are nearly cylindrical, hard, smooth and shining, and of a yellowish or reddish color. They have three pairs of legs placed far forward on the anterior extremity, and the last segment (the thirteenth counting the head) ends in a proleg on the under surface. They are surprisingly hard in texture and among the most vigorous insects known, being difficult to poison by means of anything that has been tried. A common and destructive species known as the wheat wireworm (*Agriotes mancus* Say) is illustrated by figure 45.

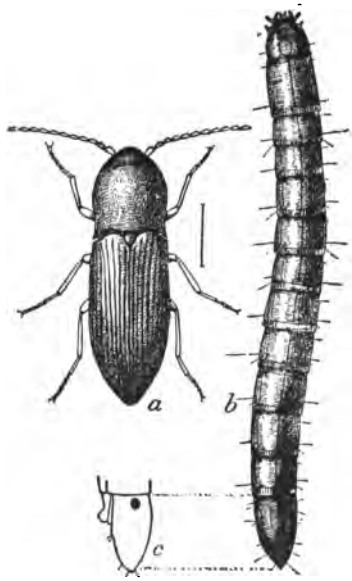

Fig. 45.—Wheat wireworm. *a*, Beetle; *b*, larva; *c*, anal segment of larva in profile. (Author's illustration, U. S. Dept. Agr.)

Fig. 46.—Common click-beetle. Three times natural size. (After Forbes.)

Wireworms are the offspring of snapping or click beetles or "snap-bugs," which are rather hard, pubescent creatures of elongate, oval form, and readily distinguishable from any other insects by the habit from which their common name has been derived, of vaulting into the air with a sudden click when they happen to fall upon their backs. The common click-beetle (*Melanotus communis* Gyll.) is shown in figure 46.

Of the various vegetable crops attacked potatoes, according to record, are most injured, by having the surface of the tubers gnawed into and eroded by the worms." Turnips suffer similar injury, as do also to a less extent carrots, beets, cabbage, onions, lettuce, and others. In attacking growing plants wireworms usually devour the smaller roots or tender tubers, according to the plant affected, and in the case of attack on corn they frequently kill the plant by boring cylindrical channels through the under-ground portions of the stalk.

The life histories and habits of wireworms vary according to species and climate, but in many respects they resemble the white grubs so closely that details may be omitted.

The Cornell University experiment station carried on, through Messrs. Comstock and Slingerland, a valuable series of experiments against these pests extending over three years, with the result that none of the alleged standard remedies produced satisfactory effects. In short, the results were negative rather than positive, and no single method has yet been devised by which we can destroy these insects as we can most other pests. This is due to natural causes—viz., to the hardness and consequent hardiness of wireworms, two qualities which go hand in hand as regards insects and which render these creatures almost impervious to poisons that would destroy other insects, and to the fact that they live during nearly their entire active stage as wireworms usually rather deeply in the soil. They require two or three years, like the white grubs, for full maturity from egg to adult.

METHODS OF CONTROL

No application that can be made to the soil will kill the wireworms without, at the same time, rendering the land unfit for cultivation for some time afterward.

Most remedies, preventives, repellents and poisons that have been tried are hardly more than palliative. From among these the ones that give most promise are early fall plowing, the use of poisoned baits early in the season, with the selection of uninfested land for planting, and rotation of crops. We are in fact confronted with much the same problems as in the treatment of white grubs, only wireworms are even more difficult of suppression.

Selection of land for planting.—The most important of defensive methods is the selection of the land for planting. It is inadvisable to plant crops peculiarly subject to wireworm attack, such as corn, potatoes, and other vegetables, as well as cereals in sod land or in unbroken prairie, and it is equally unwise to cultivate such crops in fields in which wireworms are known to be present.

Fall plowing.—Infested or "suspicious" soil should first be prepared for the crop by plowing early in the fall. By this process the cells in which the pupæ and hibernating adults are resting are broken up and the insects destroyed in great numbers, so that fewer individuals survive to deposit eggs for another generation of wireworms the following year. Such as are not destroyed outright by this method will be more exposed to the elements and to predatory enemies.

Crop rotation should also be practiced in the same manner as prescribed for white grubs. In addition to clover, buckwheat is said to be a valuable alternate because of the roots being too tough and hard to be injured, and possibly this is true of some forms of wireworms, but not of all, so we cannot place much reliance on this crop. If clover or other alternate be allowed to remain for one or two years after grass has been cut, veg-

etables subject to attack can then be planted with much less danger of serious infestation. It is difficult with our present knowledge to name an absolutely immune crop.

Poisoned baits.—An efficacious remedy is found in poisoned baits. One of these consists in sowing corn, soaked in water, containing arsenic or strychnine, over the field about ten days before the crop is planted and then harrowing it in. The larvæ that attack the poisoned kernels will be destroyed. For luring beetles, as well as larvæ, baits of sliced potatoes or other vegetables, or wads of succulent vegetation, such as clover, or pigweed, or sweetened corn-meal dough, are useful. These are poisoned in the same manner as the corn and placed about the fields under boards early in the season. These traps should be renewed as often as possible. Experiments have shown the futility of starvation of wireworms by clean fallowing.

Although these remedies are not infallible against wireworms, they are of value in certain sorts of soils against some species, and they serve in a manner to destroy white grubs and cutworms which are also apt to be present.

APHIDES, PLANT-BUGS AND RELATED INSECTS

Nearly all forms of plants are attacked by sucking insects, the aphides, plant-bugs, leafhoppers and numerous related forms. The best known are the aphides or plant-lice, many of which do injury to vegetable crops. Among other insects which obtain nourishment by suction are several species of true bugs of the family Capsidæ, generally termed plant-bugs, although some forms are also known as leaf-bugs, chinch bugs, and other names indicative of their habits or appearance. The commonest and most injurious of these insects to vegetables are two forms of false chinch bugs, the tarnished plant-bug and garden flea-hopper. The thrips also obtain their food by suction, and for convenience may be included in the same category, although they are not closely related to them structurally.

Aphides or Plant-lice.—Nearly every one knows the plant-lice or aphides, since there are few succulent plants that are exempt from their attack. Many staple crops of the field, garden, and orchard are very severely damaged when these insects multiply in unusual numbers, as so frequently happens. Aphides are also known as "lice," "aphis" and "green fly."

There are many species, as varied in appearance as in habits, and although they have attracted attention for years on account of the injuries which they cause and their interesting habits, they are perhaps less understood than any large group of insects which could be named. In fact, we are not as yet able to establish beyond a certain degree of doubt the identity of some of our most injurious forms and we know less of their life economy.

Gardens are seldom free from their attacks, and cabbage and like crops, melons, cucumbers and similar plants, peas and young budding fruit trees suffer severely in some seasons.

The best-known aphides are soft-bodied and green, very minute in size, with long legs and antennæ. Immense masses of them frequently congregate on single plants, sometimes overrunning entire fields. If a mass be closely examined it will be seen that many are wingless during the greater part of the season; later, however, there are many which develop wings and are capable of flight. There are many stages of these insects, but the body is usually formed more or less like a pear, and the winged forms have two pairs of very delicate transparent wings with a few simple veins. The first and second pairs of wings are usually connected as in wasps and bees, by a hooklet. The haustellum or beak by which aphides obtain their food is three-jointed and of variable length. The eyes are compound and project prominently at the sides of the head. The aphides exude "honey-dew," a transparent fluid with a sweetish taste. Frequently it is excreted in such quantity that it forms a shining cover to the leaves of plants. The honey-dew of most species is very attractive to a number of

other insects—ants, wasps, bees and flies—and in the fondness of ants for this substance there is developed a curious inter-relationship.

The various phases of development, the varieties of forms produced by some genera, in fact, the life economies of these

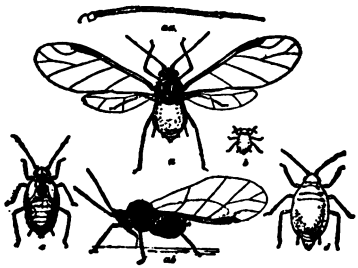

Fig. 47.—Melon aphis. *a*. Winged female; *aa*, enlarged antenna ot same; *ab*, dark female, side view; *b*, young nymph or larva *c*, last stage of nymph; *d*, wingless female—all greatly enlarged (Author s illustration, U. S. Dept. Agr.)

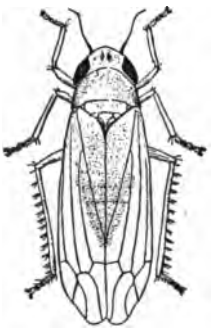

Fig. 48.—Flavescent leafhopper (*Empoasca flavescens*). Highly magnified. (Author's illustration, U. S. Dept. Agr.)

insects would fill several volumes, and there is such great diversity of habit that it is difficult to generalize.

The species which feed upon vegetable crops live for the most part on the under surface of leaves; but some are root-feeders, and the destructive grape phylloxera is an example of one of these subterranean forms which produce galls.

The melon aphis (fig. 47) is one of our commonest and best known vegetable-feeding forms of this class.

The best remedies for aphides are kerosene emulsion, fumigation with bisulphid of carbon and with tobacco extracts, clean cultural methods of farming and the encouragement of natural enemies. These remedies are considered on pages 165 to 168.

The Leafhoppers.—Leafhoppers are familiar to nearly everyone, although not everybody knows them by this name.

As we walk over lawns and through meadows and pastures generally, particularly in midsummer and later, myriads of these minute creatures fly up and are sometimes annoying by getting into our faces and even our eyes. Recently their true economic value has been ascertained, and this was brought about mainly through the studies of Prof. Herbert Osborn, in Iowa. They are most numerous in grasses from which they drain the vitality by sucking the sap from the blades. It has been estimated that between one-fourth and one-half of all the grass growing annually is destroyed by leafhoppers, a startling statement but borne out by actual observation. Although most of these insects feed on grasses, there are some which, particularly in their later stages as nymphs and as adults, attack various vegetables and other plants. Leafhoppers are mostly small, some very minute and slender, with short heads more or less crescent-shaped, and with long hind-legs which fit them for jumping. They also have long wings and are strong flyers. The species illustrated (fig. 48) attacks a variety of vegetables.

In their attacks on plants the usual method is to puncture the cells from the under side of the leaves, causing yellowish, brownish or other discolored spots to appear later. When punctures are numerous entire leaves wilt and die. A few forms attack culinary vegetables by preference, but most others occur on different plants. No less than thirty distinct species have been found on beets.

METHODS OF CONTROL.—Several methods have been devised for keeping leafhoppers in subjection. The standard remedies are kerosene-soap emulsion and sprays of soap. An underspraying is always necessary. The spray should be as fine as possible, and applied upon the first appearance of the insects, not only to produce the best effect, but because by using it early in the spring the insects may be prevented from developing in large numbers later in the season, for with many forms there are two and sometimes three generations produced annually.

Leafhoppers may also be captured on sticky surfaces, and one good way of destroying them in small gardens is by causing them to fly up and capturing them on large frames coated with sticky substances such as coal tar. If this method is persisted in for several days few of the insects will be left, as they are readily caught. A good time for this work is just before sundown. Special hopper-dozers are used for leafhoppers, similar to those described as grasshopper destroyers (page 71). Some of these are termed "hopperettes."

The Tarnished Plant-bug (*Lygus pratensis* Linn.).—This bug

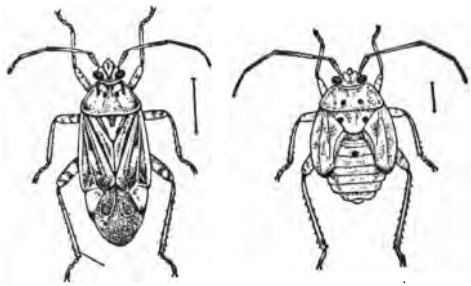

Fig. 49 —Tarnished plant-bug. Adult at left: last stage of nymph at right (Author's illustration, U. S. Dept. Agr.)

is one of the most troublesome of its kind. It is found practically everywhere in North America, and attacks many plants, cultivated and wild. It occurs throughout the warm season, and frequently does damage to vegetables and to trees grown in nurseries. The mature plant-bug (fig. 49) is of nearly elliptical form, and considerably flattened. The head is nearly triangular, with the eyes showing prominently at the sides. It is pale, obscure, grayish brown, marked with black and yellow, the thorax also with red. The length is about one-fifth of an inch. With little doubt this plant-bug has five stages of the nymphs to agree with related species which have been traced through their metamorphoses. The first stage measures only about one-

twentieth of an inch, and is yellowish green. This species is quite injurious to cabbage, turnip, potato and cucumber, and attacks also salsify and celery. The principal injury is accomplished in the spring, by the adults piercing and sucking the juices from flowers and leaf-buds, and later by attacking tender fruits and shoots.

The tarnished plant-bug is credited with being the author of "buttoning" of strawberries, and forms of "blight," the insect in the latter case acting as a transmitter of germs from diseased to healthy plants. Were it not that this plant-bug distributed its attack by feeding on a variety of crops and weeds, it would be more injurious than it is. The bugs are extremely active, quick of flight as well as of foot, and when disturbed have the habit, in common with kindred species, of hiding by dodging to the opposite side of a plant. Hibernation is usually in the adult stage. In early spring, the females deposit their eggs singly on plants, continuing for two weeks or longer. According to Prof. J. M. Stedman, three generations develop in southern Missouri, and two in the northern portion of that state. The duration of the life cycle may be placed approximately at about four weeks, or a little longer, the length of time depending on season and climate.

REMEDIES.—The standard bug remedy, kerosene emulsion, is the best, sprayed on as thoroughly as possible to all crop plants as well as weeds attacked. Pyrethrum is of value, but must be applied repeatedly and is rather expensive. Hand methods are also valuable, and a hand net is useful for sweeping the plants and surrounding grass and other vegetation. Frequently more individuals can be captured in this way than in any other. When a considerable number have been taken, they can be killed by throwing them into large pans of water with a few drops of kerosene. After the crop is off "back firing" should be practiced in the same manner as described as a remedy for army worms on page 58.

The Onion Thrips (*Thrips tabaci* Lind.).—Few gardeners are unacquainted with "thrips," of which there are several species injurious to plants grown under glass. The commonest and most destructive vegetable-feeding species in America are the onion thrips and the wheat thrips.

All thrips are exceedingly minute, the common species not exceeding one-twentieth of an inch in length. They have

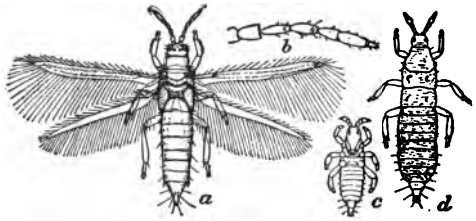

Fig. 50.—Onion thrips. *a*, Adult; *b*, antenna of same; *c*, young larva; *d*, full-grown larva—greatly enlarged (Howard, U. S. Dept. Agr.)

elongate bodies, and the winged forms have four very slender wings fringed with long, delicate hairs. These insects are somewhat anomalous in the manner of their feeding: their mouth-parts are fitted chiefly for sucking, but they also have bristle-like mandibles.

The general appearance of the onion thrips is shown in figure 50, *a*, highly magnified. It is pale yellow, with the thorax somewhat darker. The wings are paler yellow, with dusky fringes and bristles.

The parent insects are usually found on the lower sides of leaves or imbedded in flowers of various kinds. In their attacks they induce the withering of the parts affected, and they sometimes destroy entire plantings. The onion thrips injures a great variety of field and garden crops, to which it is quite as destructive as to plants grown artificially. Besides onion it injuriously affects garden leek, parsley, cabbage, celery, melon,

cucumber, squash, turnip, cauliflower and strawberry, and does more or less damage to nasturtium, mignonette, carnations, candytuft, four-o'clock and rudbeckia.

The female thrips cuts a slit, in a leaf or stem usually, to deposit her eggs. In a few days the young thrips work their way out and begin to feed. They suck the juices of plants and, as they feed continuously, their growth is rapid. The entire life-cycle from the time of the deposition of the eggs until the maturing of the adult is passed under favorable conditions, in a warm atmosphere, in three weeks. Out-of-doors in a cooler atmosphere a longer period would be required for the life cycle.

The minute size of thrips, with their habits of feeding by suction, in concealment in their host plants, renders it difficult to treat them successfully. The best contact poisons are dilute kerosene-soap emulsion, applied as for aphides (p. 361). It is practicable in some cases to dip whole plants, when being transferred from the hothouse to the field, in kerosene emulsion.

For fumigation, hydrocyanic-acid gas, carbon bisulphid and different preparations of tobacco are useful. Tobacco preparations, containing about 40 per cent. nicotine, have been found effective at the rate of 5 or 6 teaspoonfuls to 1½ pints of water when vaporized in a space of 5,000 cubic feet. This method does not injure cucumbers while nearly all the thrips on plants thus treated are killed.

In the field drenching affected plants with a hose will kill many of the pests. Clean methods of farming is a necessity, as thrips develop largely in grasses, weeds and other vegetation in and near onion fields. All other infested plants should also be treated with kerosene-soap emulsion, and the weeds burned where possible.

The Wheat Thrips (*Thrips tritici* Fitch).—This native species, also called the strawberry midget, has been reported as

doing injury to parsley, pea, endive, cotton, orchard and small fruits and roses. Its color is yellow, with the thorax tinged with orange, and the antennæ or feelers are ringed with a dusky color (fig. 15). It is distributed from Canada to Florida, and westward.

REMEDIES.—The same as for the onion thrips.

The Red Spider (*Tetranychus bimaculatus* Haw.).—Few vegetables are free from the attacks of red spider (fig. 50*x*). These creatures are extremely minute, and are frequently not noticed until they become excessively numerous, as happens during summer droughts. They do considerable damage in vegetable gardens and to plants grown under glass.

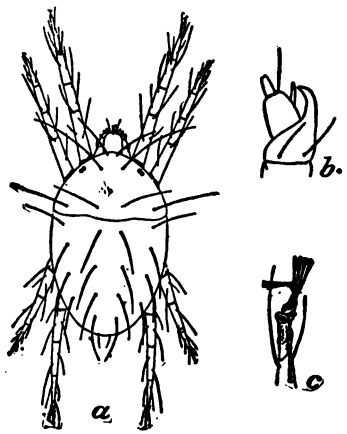

Fig. 50*x*.—Red spider. *a*, Adult; *b*, palpus; *c*, claws. (After Banks, U. S. Dept. Agr.)

REMEDIES.—Flowers of sulphur, mixed with water at the ration of one ounce to the gallon, and sprayed over the plants, is of great value in eradicating this pest. Fish-oil and other soap solutions are valuable, and the addition of sulphur increases their effectiveness, but are too strong for some delicate plants. Greenhouse plants are sprayed with water two or three times a week during the growing season, and care is exercised to wash off the spiders and not drench the beds.

Fig. 51.—Spray of asparagus, with common asparagus beetle in different stages
Natural size. (Author's illustration, U. S. Dept. Agr.)

CHAPTER VI

INSECTS INJURIOUS TO ASPARAGUS

ASPARAGUS was introduced into America with the early settlers from Europe, and was cultivated here for two hundred years before being troubled with insects. Few edible plants down to the time of the Civil War have enjoyed such immunity from the ravages of insects. The principal insect enemies of asparagus are two leaf-beetles, both imported from the Old World, and limited for food supply to this plant.

The Common Asparagus Beetle (*Crioceris asparagi* Linn.), as its English name indicates, is the more abundant asparagus

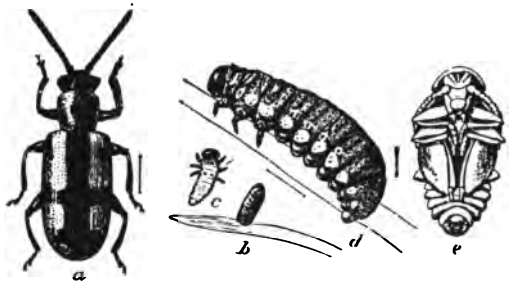

Fig. 52.—Common asparagus beetle. *a*, Beetle; *b*, egg; *c*, newly-hatched larva; *d*, full-grown larva; *e*, pupa—all enlarged. (Author's illustration)

beetle and by far the most important foe of this plant. Its first appearance was noted in this country at Astoria, near New York City, in 1860, where it was introduced about 1856.

The injury inflicted by this insect is due to the work of both adults and larvæ upon the tender shoots, which they render unfit for market early in the season. Later they destroy by defoliation growing plants, and are particularly injurious to

seedlings, the roots of which are weakened by having their tops devoured. Larvæ, as well as beetles, attack the tenderest portions of the plants, but the latter gnaw with seemingly equal relish the epidermis, or rind, of the stems.

The beetle, illustrated by figure 52, is a most beautiful creature, slender and graceful in form, blue-black in color, with red thorax, and lemon-yellow and dark-blue elytra or wing-covers, with reddish border. Its length is a trifle less than one-fourth of an inch.

From the scene of its first colonization, Queens County, N. Y., the insect migrated to other truck-growing regions, and has now extended its range northward through Connecticut and Massachusetts to the State line of New Hampshire. Southward it has traveled to southern Virginia. At the present time it is well established in the principal asparagus-growing sections of the northern Atlantic region, and occurs westward to Illinois and Michigan. In a very few years we may expect its spread to other portions of states in which it is now local, and later it will naturally move westward.

The insect passes the winter in the beetle state under convenient shelter, and in April or May, according to locality, or at the season for cutting asparagus, issues from its hibernating quarters and lays its eggs for the first brood. The eggs are deposited endwise upon the stem or foliage and in early spring on the developing stalks, in rows of from two to six or more.

In from three to eight days the eggs hatch, the young larvæ, "grubs" or "worms," presenting the appearance indicated in figure 52, *c*. They at once begin to feed, and are from ten days to a fortnight in attaining full growth. When full grown the larva appears as in figure 52, *d*. It is soft and fleshy, and in color is dark-gray or olive, which becomes lighter and yellowish with age. The mature larva enters the earth, and here, within a little rounded, dirt-covered cocoon which it forms, the pupa state is assumed. In from five to eight or more days the beetle

is produced, which issues from the ground in search of food and of a suitable place for the continuance of the species. The duration of the life cycle, according to Fitch, is about thirty days from the time the egg is laid until the insect attains maturity. In the District of Columbia the eggs, in the warmest part of midsummer, develop in three and the pupæ in five days. In the present range of the species two and perhaps three broods are usually produced. The beetles enter into hibernation in September.

The asparagus beetle has efficient checks in predaceous insects, which prey upon its larvæ and assist in preventing its undue increase. Among these are the spotted ladybird (*Megilla maculata* DeG.), the spined soldier-bug (*Podisus maculiventris* Say) and the bordered soldier-bug (*Stiretrus anchorago* Fab., fig. 53). Wasps and small dragon flies also prey upon the larvæ. Immense numbers of beetles are sometimes killed in winter during severe cold spells following "open" weather.

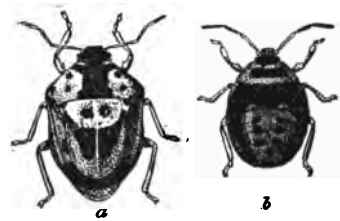

Fig. 53.—Bordered soldier-bug. Enlarged (Author's illustration, U. S. Dept. Agr.)

REMEDIES.—The common asparagus beetle, under ordinary circumstances, may be held in restraint by the simplest means.

Chickens and ducks are efficient destroyers of them, and their services are often brought into requisition for this purpose.

A practice in high favor is to cut down all plants, including volunteer growth, in early spring to force the beetles to deposit their eggs upon new shoots, which are then cut every few days before the eggs hatch. Another measure of value consists in permitting a portion of the shoots to grow and serve as lures for the beetles. Here they are killed with insecticides, or the plants after they become covered with eggs are cut down and burned, and other shoots are allowed to grow up as decoys.

One of the best remedies against the larvæ is fresh, air-slaked lime dusted on the plants in the early morning while the dew is on. It quickly destroys all the grubs with which it comes in contact.

The arsenicals, applied dry in powder mixed with lime, answer well, and possess the advantage of destroying beetles as well as grubs, and are of value upon plants that are not being cut for food. To produce satisfactory results the lime or arsenite must be applied at frequent intervals, or as often as the larvæ reappear on the beds. Arsenate of lead is an excellent remedy.

A simple method of killing the larvæ in hot weather is to brush them from the plants so that they will drop to the heated earth, where they die before being able to return.

The Twelve-spotted Asparagus Beetle (*Crioceris 12-punctata* Linn.).—The chief source of damage from this species is from the work of the hibernated beetles in early spring on young and edible asparagus shoots. Later the beetles as well as larvæ appear to feed exclusively on the berries. The eggs are deposited singly, and apparently by preference, on old plants toward the ends of shoots, which, lower down, bear ripening berries, and they are attached along their sides instead of at one end, as with the common species. Soon after the larva hatches from the egg it finds its way to an asparagus berry, enters it, and feeds upon the pulp. In due time it leaves this berry for another one, and when full growth is attained it deserts its last habitation and enters the earth, where it transforms to pupa and afterwards to the beetle. The life cycle does not differ materially from that of the common species, and there are probably as many generations developed.

This species is at present distributed throughout nearly the same territory of the North as the preceding. The beetle rivals the common asparagus species in beauty, but may be distinguished by its much broader wing-covers and color. It is orange red, and each wing-cover is marked with six black dots, and the knees and a portion of the under surface of the thorax are also

marked with black (fig. 54, *a*). The beetle as it occurs on plants when in fruit very closely resembles, at a little distance, a ripe asparagus berry.

The full-grown larva is shown at figure 54, *b*. It measures,

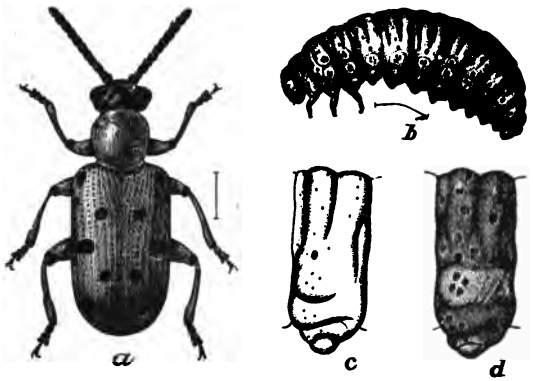

Fig 54.—Twelve-spotted asparagus beetle. *a*. Beetle; *b*, larva; *c*, second abdominal segment of larva; *d* same of common asparagus beetle. *a*, *b*, Enlarged; *c*, *d*, more enlarged (Chittenden, U S Dept. Agr.)

when extended, three-tenths of an inch, being of about the same proportions as the larva of the common species, but is readily separable by its ochraceous orange color.

Remedies are those indicated for the common asparagus beetle, with the exception of caustic lime and other measures that are directed solely against that species, but the habit of the larva of living within the berry places it for that period beyond the reach of insecticides.

The Asparagus Miner (*Agromyza simplex* Loew.).—Asparagus stalks are sometimes considerably injured by a maggot (fig. 55*x*, *a*) which mines under the skin near or just beneath the base. The appearance of the affected stalk (*f*) is characteristic. The parent insect is a small black fly.

Remedial Suggestions.—Permit a few volunteer asparagus

plants to grow as traps to lure the female fly to deposit her eggs. Afterward, in late June or early July, pull the trap

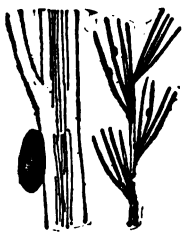

Fig. 55.—*Crioceris 12-punctata*. Egg, natural size, on asparagus, right; enlarged at left. (Chittenden, U. S. Dept. Agr.)

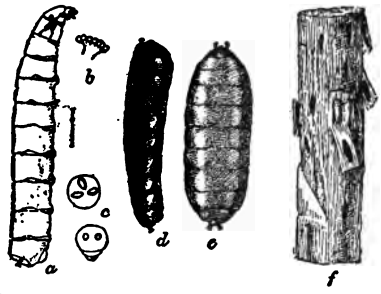

Fig. 55*x*.—Asparagus miner. *a*, Larva; *b*, *c*, spiracles; *d*, *e*, puparium; *f*, section of asparagus stalk, showing injury and puparia. *a-e*, Much enlarged; *f*, slightly reduced. (Author's illustration, U. S. Dept. Agr.)

plants and promptly burn them with their contained insects (in the flaxseed stage, fig. 55*x*, *d*, *e*).

If this is carefully done over a considerable area, there will be little necessity for other methods, as few insects will be left for another season; unless, indeed, this insect has an alternate food plant. Cooperation and thoroughness are essentials for success. This method will operate also against the rust which is often present in fields infested by the miner.

CHAPTER VII

INSECTS INJURIOUS TO BEANS AND PEAS

EDIBLE legumes are subject to injury by certain weevils, which deposit their eggs upon or within the pods on the growing plants and develop within the seed. The specific enemy of the pea is the pea weevil, and of the bean, the common bean weevil, both of sufficiently wide distribution and abundance to hold high rank among injurious insects. The inroads of these weevils in seeds cause great waste, and particularly is this true of seed kept in store for any considerable time. In former times popular opinion held that the germination of leguminous food seed was not impaired by the action of the larval beetle in its interior, but this belief is erroneous, as will be shown in the discussion of the nature of the damage by the pea weevil.

Although it is not probable that any serious trouble follows the consumption by human beings of the immature weevils in green peas or beans, the use for food of badly infested dry seed filled with the dead bodies and excrement of the beetles would naturally be attended with unpleasant consequences.

Growing pods in the fields are invaded by the bollworm and pea moth, and the foliage is preyed upon by numerous insects. Of foliage feeders are the bean leaf-beetle, bean ladybird, blister beetles, cutworms, and other caterpillars. Several forms of plant-bugs, leafhoppers, and aphides also exhaust the plants by sapping their juices.

The Pea Weevil (*Bruchus pisorum* Linn.).—Seed peas are often found with a single round hole in them, due to the attack of the pea weevil or "pea bug," the largest of the pea and bean-

feeding weevils found in this country, measuring about a fifth of an inch in length. Its ground color is black, but it is thickly covered with brown pubescence, variegated with black and white markings arranged as illustrated in figure 57, *a*.

Fig. 56.—A buggy pea

In 1748 the celebrated Swedish naturalist Pehr Kalm gave an account of this weevil, stating that the culture of the pea had been abandoned in Pennsylvania, New Jersey, and southern New York on account of it.

There are reasons for believing that this species came originally, with so many other injurious insects which live upon cultivated seeds, from the Orient, and it has now become distributed over nearly the entire globe, wherever peas are cultivated. It does comparatively little damage in the colder parts of Canada; hence, seed peas for planting in the United States are largely imported from Canada or are bought from seed dealers who obtain them from our more northern states.

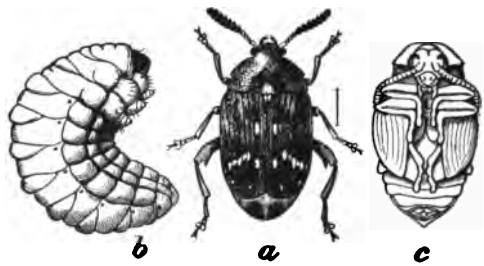

Fig. 57.—Pea weevil. *a*, Adult beetle; *b*, larva; *c*, pupa. All greatly enlarged (Author's illustration, U. S. Dept. Agr.)

Nature of injury.—Every pea in a pod is sometimes infested with this weevil; and although nearly every one is familiar with "buggy" peas, it is not generally known that in eating green peas we often eat also a "worm" with nearly every pea. The only external evidence of infestation in a green pea is a minute

dot on its surface, but in dry seed the cell inhabited by the insect is visible under the skin.

The belief was once more or less prevalent that the larva working within the seed, by some wonderful instinct, avoided the germ or embryo, and that weevil-infested peas were therefore of equal value for seed to uninfested ones, but this is incorrect. Many "weeviled" seed will germinate, but as they are deficient in plant food the resulting plant is apt to be weakly and nonproductive.

This species develops only a single generation annually. As it does not breed in dry peas, the new generation for another year is dependent on such beetles as are contained in planted seed or which escape from the storeroom.

REMEDIES

Holding over seed.—A simple and effective remedy consists merely in keeping seed peas in a close receptacle, a tight bag or box, over one season before planting. The beetles which issue die without being able to lay their eggs in the field. Primary injury to the seed has been effected by the larva the first summer and after the weevil develops, always during the first autumn in the writer's experience, further damage practically ceases.

Late planting.—Comparative immunity from pea weevil attack is claimed in some localities, *e. g.,* in the southern states, by planting late, and is all that is necessary to secure sound seed stock.

Bisulphid of carbon.—When it is desired to plant the first season after gathering the seed, bags in which peas have been kept tightly closed should be placed in a tight box or vessel and disinfected with bisulphid of carbon, at the rate of an ounce or two to 100 pounds of seed. This method will kill the weevils

without injury to the germinative property of the seed. A similar remedy consists in soaking infested seed for one minute in boiling water. A longer time is apt to injure it for planting.

Fig. 58.—Common bean weevil. Greatly enlarged. (Author's illustration, U. S. Dept. Agr.)

No efficient preventive of injury is known, but cooperation in the treatment of infested seed would render further action unnecessary.

The Common Bean Weevil (*Bruchus obtectus* Say).—The most formidable enemy to the culture of beans is the common bean weevil. In the nature of its attack it differs from the pea weevil in that it not only develops in the pods in the field but continues to breed for successive generations in seed, after harvest and storage, until the seed is useless for planting or as food for man or stock.

As with peas, the market gardens of the North provide the dry seed for consumption and for planting in the Southern States. In and about Washington, D. C., it is next to impossible to procure a crop of beans uninfested by this weevil; hence, the stores of the city are supplied mainly from the North, New York State furnishing the greatest quantities.

This bean weevil is smaller than the preceding, averaging about an eighth of an inch in length. It is coated with fine brown-gray and olive pubescence which gives the body that color. The wing-covers are mottled, as shown in figures 58 and 60. From the pea weevil this species may be known by the different shaped thorax and the two small teeth in addition to the large tooth with which the thighs are armed. In figure 60, *a*, the beetle is represented in profile with its head bent under in natural

resting position. Until recently this species, like the preceding, was generally believed to be indigenous. It is certainly not native to the United States, and if introduced from the Eastern Hemisphere probably became acclimated in tropical America before establishing itself in the North. Its distribution is now

Fig. 59.—Bean showing injury by common bean weevil. (From Riley.)

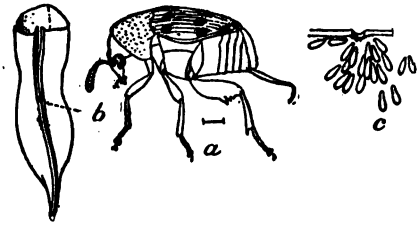

Fig. 60.—Bean weevil. *a*, In profile; *b*, section of bean-pod showing slit for egg deposit; *c*, portion of interior of pod showing egg mass inserted through slit. *a*, *c*, Much enlarged. (Reengraved from Riley, U. S. Dept. Agr.)

world-wide. It occurs in nearly every State and Territory of the Union, and is generally diffused through Central and South America.

Oviposition takes place primarily in the field, the eggs being deposited, as with the pea weevil, upon or inserted in the pod through a hole made by the female and through openings, such as are caused by its drying and splitting. In shelled beans the eggs are dropped loosely in the receptacle in which they are stored, or are placed in holes made by the weevils in their exit from the seed. Less seldom they are attached to the outer surface of the seed.

There are probably produced annually an average of six generations in latitudes such as the District of Columbia and a less number in more northern localities. Unlike the pea weevil, a large number of individuals will develop in a bean, as many as twenty-eight having been found in a single seed.

Any single indoor generation is capable of exhausting seed and completely ruining it for food or planting or any other practical purpose. The beetles begin to issue in the field in a climate like that of the District of Columbia as early as October, when in the natural course of events the eggs for a new brood would be deposited in such pods as had cracked open so as to expose the seeds within. This beetle prefers the bean as a host plant, but it will also breed in cowpeas in the field as well as in store, and in confinement develops in dried peas, lentils, and chick-peas. It is no more true of seed infested by this species than of that attacked by the pea weevil that germination is not impaired by the work of the weevil in the bean. Weeviled beans should not be planted. In a test only 50 per cent. of the infested seed used germinated, and only 30 per cent. could have passed the germinating stage, and these, owing to injury to the seed leaves, would probably have produced plants of low vigor and correspondingly low productiveness.

REMEDIES.—From the fact that this species breeds continuously in dried seed, neither the expedient of holding over seed for a year before planting nor that of planting late for seed stock would be productive of good, as in the case of the pea weevil. Recourse must therefore be had to fumigation or to heat, and the earlier the seed is treated after it has been gathered the better the result. Just before it is planted seed infested with this bean weevil should be lightly thrown into water. Badly injured seed will float, and may be picked out or poured off and destroyed. Sound seed only should be reserved for planting.

The Cowpea Weevil (*Bruchus chinensis* Linn.).—Cowpeas are quite liable to be infested by the cowpea weevil and the four-spotted bean weevil, which injure its seed in the same manner as the common bean weevil. Like that species they begin work in the field and continue to breed in the stored seed,

until they entirely spoil it, or seriously impair its germinating power. Both species are generally distributed and injurious in the South, and are widening their range with the increasing use of their food plant as a soil renovator and as forage. They resemble each other after a manner superficially, in appearance as in habit, but they differ to some extent in various details of their life economy as well as in structure.

Fig. 61.—Cowpea weevil. (Author's illustration, U. S. Dept. Agr.)

The cowpea weevil may be readily distinguished from the kindred four-spotted species by the two large, elevated ivory-like lobes at the base of the thorax and by the strongly pectinate antennæ of the male (fig. 61). This is undoubtedly an Old World species and an ancient enemy of edible pulse.

Cowpea is the favorite food seed, but the insect is also injurious to common and pigeon peas, lentils, chick-pea and "mungo." Table beans also serve as food. Material infested by this weevil undergoes a marked elevation in temperature. In one instance the temperature of a small sack of seed infested by the cowpea weevil was found to be 25° F. higher than the surrounding atmosphere.

REMEDIES.—The similarity of the habits of this and the common bean weevil renders it amenable to the same remedies.

The Four-spotted Bean Weevil (*Bruchus quadrimaculatus* Fab.) is the more slender species and differs from the cowpea weevil by many characters. What appears to be the commonest form of coloration is illustrated in figure 62, *a*, which is sufficient to separate it from the preceding which it much resembles, especially in its manner of life.

THE REMEDIES are practically the same as for the common bean weevil.

The Seed-corn Maggot (*Pegomya fusciceps* Zett.).—When the seeds of beans, peas, corn and other plants fail to develop, damage is frequently due to a maggot which works by scraping the seeds, sprouts, roots, stalks, and stems of plants underground.[1] Where this insect works decay soon sets in and the plants die. Entire plantings are sometimes destroyed, but when only a few seeds or sprouting plants are attacked,

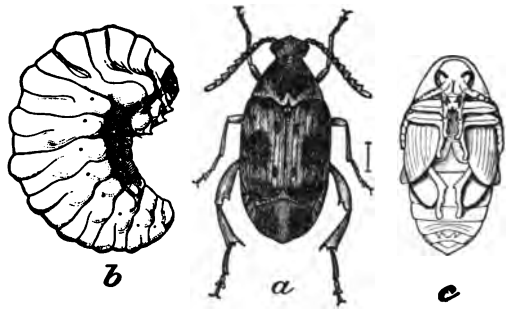

Fig. 62. Fou.-spotted bean weevil. *a*, Beetle: *b*, larva; *c*, pupa All enlarged. (Author's illustration, U S. Dept. Agr.)

injury may escape notice. Early crops suffer most and if they can be preserved until larger growth they will as a rule sustain considerable attack without material damage.

The insect in question is called the seed-corn maggot and bean fly, and its parent looks like a small house fly. It can be identified by the male (fig. 63, *a*).[2] The female can scarcely be distinguished from related species, such as the adults of the cabbage root-maggot and onion maggot. The length is about one-fifth inch and the wing expanse about two-fifths. The larva is footless and of cylindrical form (*d*), narrowed at the anterior extremity and enlarged posteriorly. It is considerably smaller

[1] Injury of this character is also committed by wireworms, white grubs and some other insects, *e. g.*, weevils in the seeds.

[2] His principal characteristics consist of a row of short, rigid, bristly hairs of nearly equal length on the inner side of the posterior tibiæ or shanks.

than the onion maggot, measuring about one-fourth of an inch.

This fly is evidently of European origin, and was first recognized in New York State in 1856. Like so many other flies, it ranges through several life areas, and we know of its occurrence in New England, Canada and Minnesota, southward to the Gulf, and westward to the Pacific.

Injury is most severe to young plants, and particularly to beans, peas, and Indian corn. Cabbage, turnip, radish, beets,

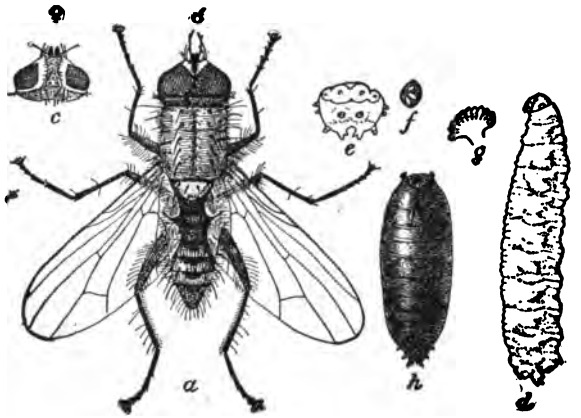

Fig. 63.—Seed-corn maggot. *a*, Male fly; *c*, head of female; *d*, larva, from side; *e*, anal segment of larva; *f*, anal spiracles; *g*, thoracic spiracles; *h*, puparium. All much enlarged. (Author's illustration, U. S. Dept. Agr.)

onion, seed potato and hedge mustard are also attacked, and the maggots even feed on the eggs of grasshoppers. The insect apparently breeds on decaying vegetable and perhaps animal matter of various kinds. A single generation only develops in corn, but later ones might be produced on bean and pea, owing to the longer period in which these crops are grown. The flies are found southward throughout the year, but in the north there must be a period in midwinter in which breeding ceases; perhaps also another in midsummer.

METHODS OF CONTROL

Owing to the difficulty of destroying root-maggots and the cost of the chemicals, growers depend largely upon methods of prevention which should be employed *before* the insect's eggs are laid.

Sand and kerosene, for deterring the parent flies from depositing their eggs, consists in placing sand soaked in kerosene —a cupful to a bucket of dry sand—at the base of the plants, along the rows. This will also kill young maggots that might attempt to work through it.

Mineral fertilizers are useful as deterrents, if employed just before or after a shower has thoroughly wet the ground. The principal fertilizers for the purpose are kainit, nitrate of soda, and chlorid of potash. They are used as top dressings before planting; and afterwards, when they should be applied as nearly as possible to the roots, the earth being turned away from the plants for this purpose. These fertilizers possess the advantage of acting also as a stimulant to plant growth, thereby facilitating recuperation from root-maggot attack.

Danger from organic fertilizers.—Stable manure and organic fertilizers are apt to induce infestation, since this species develops in excrement and other decomposing material. Numerous instances of this have come to the writer's knowledge. It is advisable, therefore, to avoid the use of manure, rotted leaves, or other organic fertilizers, and to avoid planting in fields in which there have been infested or diseased plants.

Hellebore is used with some degree of success in Canada as a remedy for the cabbage and onion maggots.

Carbolic acid emulsion diluted about 35 to 50 times, is particularly applicable when this species occurs in radish and other plants than cabbage and cauliflower.

Hand-picking, although laborious, has the merit of effectiveness and has been practiced with much success by extensive growers. It consists in lifting out the young plants, examining

the roots for the maggots, and washing them in a strong solution of soap, after which they are replanted and in two or three weeks show no ill effects of the treatment. By careful watching the eggs may be seen about the stalks of the young cabbage plants, and if the soil about these plants be raked away so as to expose the eggs to the sun they will dry up, thus preventing the maggots from hatching.

Covering young plants of cabbage and cauliflower in seed-beds is also practiced with some success in Canada.

The Bean Ladybird (*Epilachna corrupta* Muls.).—This species is limited in its operation as regards the number of crop plants

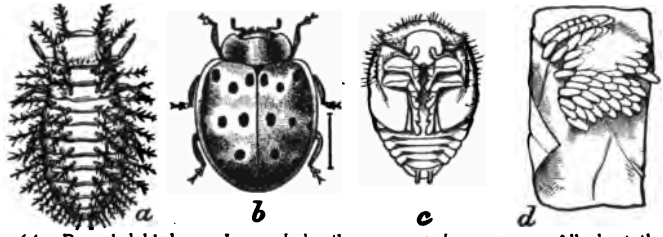

Fig. 64.—Bean ladybird. *a*, Larva; *b*, beetle; *c*, pupa; *d*, egg mass. All about three times natural size. (Author's illustration, U. S. Dept. Agr.)

affected and the territory invaded. It is one of three native ladybirds that live by choice on vegetables, the others being predaceous and subsisting largely on plant-lice and soft-bodied larvæ. It is nearly hemispherical, and its length is a little more than a fourth of an inch. In color it is light yellowish brown, and each wing-cover bears four black spots (fig. 64, *b*).

Its distribution comprises Colorado, New Mexico, Arizona, western Kansas, and Mexico.

The insect is described as being the worst enemy to the bean crop in the West, its work being compared to that of the Colorado potato beetle. It devours all parts of a bean plant, leaves, flowers, and green pods. The female deposits her yellowish-brown eggs in large clusters (fig. 64, *d*), and the larvæ feed chiefly on the lower sides of the leaves. The full-grown larva

(*a*) is yellow and covered with stout branched spines. Winter is passed in the adult stage, and a single generation has been observed.

REMEDIES.—Arsenate of lead is preferable to Paris green for use on beans since, unless great care be taken in the application of the latter, it is liable to scorch the leaves. Kerosene emulsion has given good results, and is not open to the objection

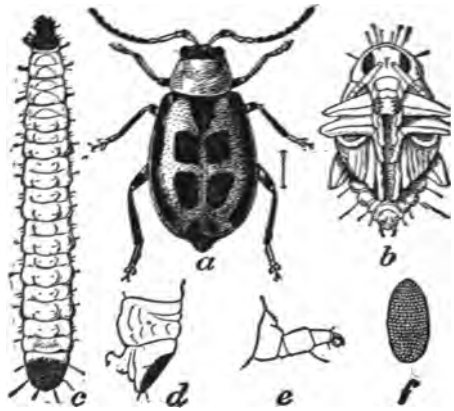

Fig. 65.—Bean leaf-beetle. *a*, Adult beetle; *b*, pupa; *c*, larva; *d*, side view of anal segment of larva; *e*, leg of same; *f*, egg. *a*, *b*, *c*, Enlarged about six times; *d*, *e*, *f*, more enlarged. (Author's illustration, U. S. Dept. Agr.)

of poisoning the plants as in the case of an arsenical. Hand-picking the beetles and eggs on their earliest appearance is a measure of prevention that would compensate for the time and labor in kitchen gardens.

The Bean Leaf-beetle (*Cerotoma trifurcata* Forst.).—An insect of considerable importance in the Gulf States, and in some years farther north is the bean leaf-beetle. It has attracted attention by its injuries in New Jersey, Louisiana, Indiana, Delaware, Ohio, Maryland, and Virginia. Injury is due to the adult beetle, which eats large, round holes in growing leaves of bean and cowpea, and certain other leguminous plants, including

cultivated beggarweed or tickseed. The larvæ feed on the roots and main stems of the same plants just below the surface.

The beetle resembles in several particulars the cucumber beetles. It measures from a seventh to a fifth of an inch in length, and varies in color from pale yellowish or buff to dull greasy red, with black markings, arranged, in what appears to be the typical form, as in figure 65, *a*. Individuals occur, however, in which the elytral marking is entirely wanting.

This species is native and found from Canada southward to the Gulf States and westward to Kansas and Minnesota.

In the South the beetles appear in April, and northward as late as June. The minute orange-colored eggs (fig. 65, *f*) are laid about the stem of the insects' food plant, in clusters of six or more, and the larvæ eat around the stem and roots.

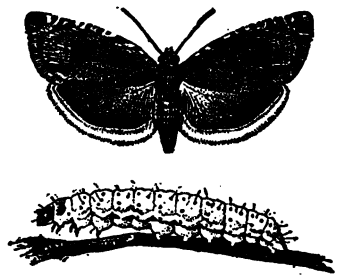

Fig. 66.—Pea moth (Steph.) Moth above, larva below. About three times natural size. (Author's illustration, U. S. Dept. Agr.)

REMEDIES.—Hand-picking and pyrethrum are useful in small gardens early in the season; but our chief reliance is in arsenicals when the insect is numerous. Arsenate of lead should be employed on the first appearance of the beetles in order to stop them at the outset. An important measure is the careful weeding out of wild food plants, such as tick trefoil and bush-clover, in the neighborhood of cultivated fields.

The Pea Moth (*Semasia nigricana* Steph.).—In Canada, where pea-growing is an important industry, there is, in addition to the pea weevil discussed in previous pages, a seed-infesting insect known as the pea moth, the larva of which develops in ripening peas in the pods. The moth (fig. 66) is a small Tortricid, with a wing expanse of about half an inch. The

larva is whitish-yellow with a pale brown head and thoracic shield, the latter inconspicuous. This is a comparatively new importation from the Old World and it is as yet unknown in the United States, but it will probably in time invade our Northern States, and pea-growers should be warned against it. The remedy which gives best results is early planting of the earliest ripening varieties.

The Bean Leaf-roller (*Eudamus proteus* Linn.).—This species is injurious in the Gulf States to beans, cowpea and cultivated

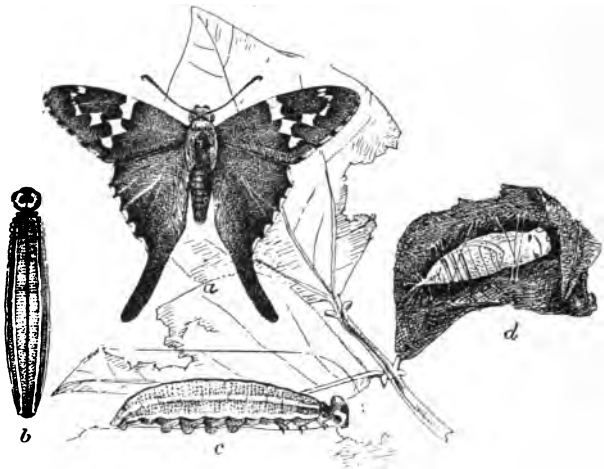

Fig. 67.—Bean leaf-roller. *a*, Butterfly; *b*, larva, dorsal view; *c*, larva, lateral view; *d*, pupa in rolled-up leaf. Somewhat enlarged. (Author's illustration, U. S. Dept. Agr.)

"beggarweed." It is the caterpillar of a butterfly called the swallow-tailed skipper. The ground color of the caterpillar is yellowish, its head being darker and marked with two orange spots near the mandibles. The head is prominent and separated from the body by the narrow neck, a character which will distinguish it from any other common caterpillar on garden crops (fig. 67).

Cutworms and Other Caterpillars.—Numerous other caterpillars devour the foliage of beans and peas of which cutworms are among the most important, often causing extensive damage to young plants by cutting them off near the ground, and to older plants by severing their leaves and tender shoots. Cutworm remedies are considered on page 54.

A green-striped caterpillar (fig. 68), misnamed the bean cutworm (*Ogdoconta cinereola* Guen.), does injury to the foliage

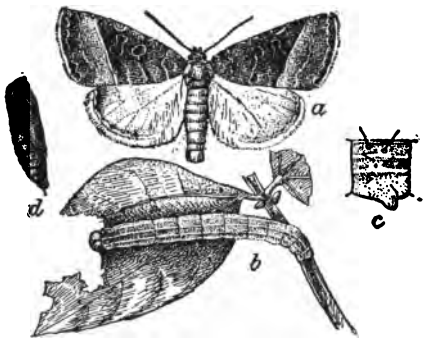

Fig. 68.—Bean cutworm (*Ogdoconta cinereola*). *a*, Moth; *b*, larva; *c*, abdominal segments of larva; *d*, pupa. All enlarged. (Author's illustration, U. S. Dept. Agr.)

and pods of beans, sometimes stripping the vines bare. Other troublesome species include the zebra caterpillars, the yellow bear and salt-marsh caterpillars.

The bollworm or corn-ear worm (*Heliothis obsoleta* Fab.) is a very serious enemy of beans frequently destroying the seed by crawling into the green pods. No means of preventing this form of injury is known. A more extended account of this pest will be given under "Insects Injurious to Sweet Corn."

The caterpillar of a beautiful little butterfly, the gray hairstreak (*Thecla melinus* Hbn.) is sometimes injurious to beans and peas by eating into the pods. The butterfly is on the wing almost continuously from May to September in the North, and from March to November farther South. This species seldom

does severe damage, hence little precaution need be observed in the treatment of it, further than to destroy all affected pods,

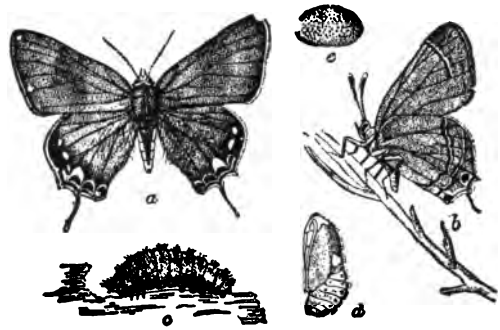

Fig. 69.—Gray hair-streak. *a*, *b*, Butterfly; *c*, larva; *d*, pupa; *e*, egg, much enlarged; others somewhat enlarged. (Howard & Chittenden, U. S. Dept. Agr.)

that the insect may not develop and do injury later and in after years (fig. 69).

It may be successfully controlled by a spraying with an arsenical on its first appearance.

The Pea Aphis (*Nectarophora destructor* Johns.).—Until the year 1899 peas grown in the United States suffered little injury from insects other than the pea weevil. In that and the following year, however, this crop was badly injured by the pea aphis, which caused enormous losses in our principal pea-growing regions, especially where peas are grown for canning. It was, in fact, one of the most destructive of all insects that ravaged crops in the United States at that time.

This aphis is of unusual size among those found in gardens, and the largest green species which attack the pea and related plants. The length of the body of winged viviparous females is about 3/16 inch, and the total wing expanse about 4/10 inch. The general color of both the winged and apterous or wingless forms is uniform pea-green, the same as its food plants. As to whether this insect is native or of foreign origin there is still some doubt.

During the years mentioned this pea aphis overran and laid waste fields of peas from Nova Scotia to Virginia and Maryland, in the last as well as neighboring States, destroying about 50 per cent. of the annual output, and this in spite of vigorous efforts that were made to control it. An estimate of the loss for 1899 along the Atlantic Coast States reached the sum of

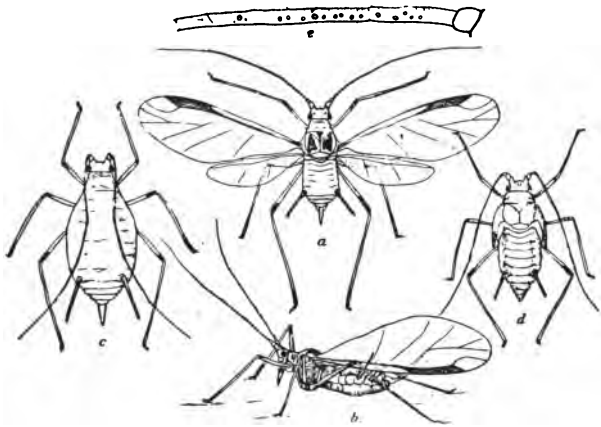

Fig. 70.—Pea aphis. *a*, Winged female; *b*, same from side with wings folded in natural position when feeding; *c*, apterous female; *d*, nymph in last stage; *e*, third joint of antenna of winged form. *a-d*, Much enlarged; *e*, more highly magnified. (Author's illustration, U. S. Dept. Agr.)

$3,000,000. During 1900 the loss over the same area was placed as early as June 15 at $4,000,000. Several cases of severe damage were reported, in which 80 or more per cent. of the peas on farms of 500 or 600 acres were completely destroyed. In short, pea-growers as far westward as Wisconsin sustained such severe losses as to give rise to the expression that the country had been visited by a veritable scourge.

Attack begins on the young vines; the "lice" gather in clusters about the terminals, and as the leaves become covered they attack the stems, and by their numbers and voracity sap the life of the plant. Whole areas are frequently seen covered with

the "lice," which in a very few weeks destroy a crop. Attack is seldom noticed until May in the more Southern States in which the insect is found, and a little later in its more northern range. It hibernates on clover and vetch, and from these plants spreads by flight in April and May to peas. The females at certain periods produce living young. These attain maturity in from ten to fifteen days, and possibly in less time in the hottest weather. Several generations develop each year. As instance of the reproductive powers of this insect, Prof. W. G. Johnson's estimate is interesting. Females produce from 110 to 120 young. Calculating from the average number of insects produced each day (six), one individual would in one year become the progenitor of 423,912 "lice."

In some instances natural enemies of the pea aphis have done efficient service. Seldom, however, do they destroy the insects sufficiently early in the season to save a crop.

REMEDIES

Kerosene-soap emulsion, carefully prepared and diluted with about twelve parts of water, and sprayed upon the plants upon the first appearance of the "lice," so that the leaves are wet on both the under and upper surfaces, has been found to be the most effective of the insecticides tried. A stronger solution is apt to scald the plant, particularly while the vines are young and tender. The cost of the emulsion, however, and the difficulty of under-spraying, its rapid evaporation, and the necessity of frequent applications, is such as to hardly warrant its use.

Brush and cultivator method.—The peas are grown in rows sufficiently wide apart as to admit of a one-horse cultivator between them. The "lice" are brushed from the plants with boughs of pine with their leaves on, and a cultivator follows down the rows immediately afterward. This method should be practiced in the heat of the day, when the ground is dry and hot, and a repetition of the brushing is necessary every three

to seven days until the crop is ready for picking. Such "lice" as are not buried in the ground will be killed by the dust which closes their breathing pores, while a considerable proportion are destroyed also by the force of the brushing. Peas planted in rows to permit of frequent cultivation suffer much less injury than when sown broadcast. As soon as the last picking has been made infested plants should be promptly plowed under.

Cultural methods.—Of cultural methods there is testimony to the value of early planting, the earliest peas seldom being infested, or at least only slightly injured. Very late plantings of peas for canning have also escaped ravages in some instances.

Rotation of crops is advisable, and it is unwise to plant peas in successive years in the same portion of a farm, or in the vicinity of other leguminous plants likely to harbor this species.

As this insect passes the winter on the plants mentioned, because peas are not available, it might be possible to use small plats of some of them as trap crops. Crimson clover would probably be best because of the early start that it gets in the spring. On the trap plants the "lice" could be killed by hand methods, such as brushing from the plants into pans, and thus large numbers could be killed early in the season before they had opportunity to spread to peas.

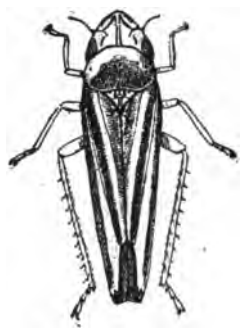

Fig. 71.—Crafty leafhopper. Adult. (Author's illustration, U. S. Dept. Agr.)

Leafhoppers of several species occur in all stages, feeding on the under surface of leaves of bean and cowpea, but are not known to be particularly injurious. The most conspicuous species, on account of its large size and bright colors, is the crafty leafhopper (*Diedrocephala versuta* Say, fig. 71). Remedies have been discussed on page 86.

Plant-bugs are often abundant on edible legumes. Of these

CHAPTER VIII

INSECTS INJURIOUS TO BEETS AND SPINACH

THE recent extension of the sugar-beet industry in this country has been the means of bringing to notice a large number of insects not previously identified with that plant. Owing to its lesser prominence as a merchantable product, spinach is not grown to the same extent, and it follows that its known insect enemies are fewer still. With the exception of some insects which will be mentioned, the majority of those which live more or less habitually on beets and spinach feed normally on related wild plants, including the goosefoot, amaranth, saltbush and the like. During the last quarter century several insects have been so prominent as pests in fields of sugar-beet, that they have received names indicative of their beet-feeding habit, while some few take their common names from spinach. Of these are the beet army worm, beet webworm, spinach leaf-miner, spinach flea-beetle, beet carrion-beetle and the beet aphis. Up to 1907 nearly 200 species of insects have been observed to use beets as food.

The greatest losses from insect attack are probably due to flea-beetles, but they, as well as cutworms and similar groups, are so irregular in their depredations that an exact estimate cannot be made. Different species of leaf-beetles and caterpillars, other than cutworms, do more or less injury, and several blister beetles devour the foliage of sugar and table beets freely; most forms of the last, however, usually make their appearance so late in the season that, although defoliation may be excessive, comparatively little damage is accomplished. The same is true of some species of grasshoppers. Two common forms of farm

insects, white grubs and wireworms, are at times injurious to the roots, and root-aphides injure the roots so as to render them comparatively useless.

FLEA-BEETLES AND LEAF-BEETLES

As flea-beetles are among the most troublesome sugar-beet pests from their early occurrence and the rapidity with which

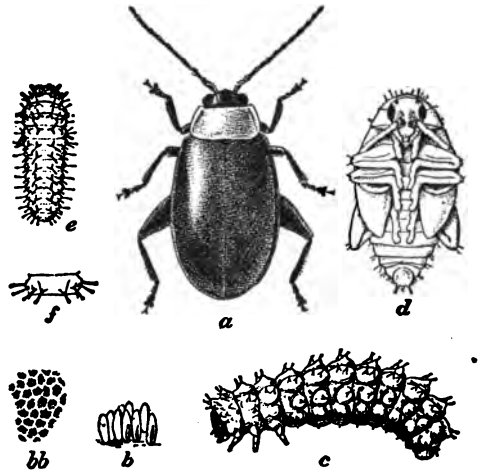

Fig. 75.—Spinach flea-beetle. *a*, Beetle; *b*, egg mass, showing mode of escape of larva at right; *bb*, sculpture of egg; *c*, full-grown larva; *d*, pupa; *e*, newly-hatched larva; *f*, abdominal segment of same. *a*, *c*, *d*, Five times natural size; *b*, *e*, more enlarged; *bb*, *f*, still more enlarged. (Author's illustration, U. S. Dept. Agr.)

they work, they may receive first mention, especially as no less than twenty forms have been observed attacking this plant. Some of these are widely distributed; others are local. Most farmers are familiar with flea-beetles, better known perhaps as "fleas," and it will be unnecessary to enter into detail in regard to more than one species.

The Spinach Flea-beetle (*Disonycha xanthomelæna* Dalm.).—This flea-beetle (fig. 75) is black with a reddish-yellow thorax. It appears early and, like other species of its kind, works

rapidly. It can be controlled in the same manner as other flea-beetles and leaf-beetles, and there is no doubt that if growers took pains not to allow chickweed and lambsquarters to spring up in the fields that the insect could be still more easily destroyed, as the first generation is produced on this and some similar weeds, and it is the second generation which attacks the beets. Its young, or larva, has the same habit as the adult, and the species frequently "cleans out" entire rows of beets before its appearance is suspected.

REMEDIES for flea-beetles are discussed on page 65.

The Larger Beet Leaf-beetle (*Monoxia puncticollis* Say).—Two species of native leaf-beetles are important enemies of the sugar-beet in the West, where they are sometimes known as "French bugs" and "alkali bugs."

The larger beet leaf-beetle (fig. 76) lays her eggs on the under side of leaves, where they hatch in about six days, the young larvæ commence feeding at once, continuing for nine or

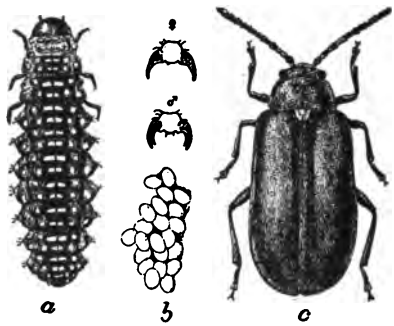

Fig. 76.—Larger beet leaf-beetle. *a*, Female beetle; *b*, eggs; *c*, larva; ♂, male claw; ♀, female claw. All much enlarged; claws more enlarged. (Author's illustration. U. S. Dept. Agr.)

ten days, when they dig their way into the ground, and, a few days later, come forth as beetles. Damage is due to both the larvæ and beetles, hundreds occurring on a single plant, which

is either consumed or so injured that it shrivels and dies. Since 1897 this species has done more or less injury to sugar-beet in Colorado, Idaho, Utah and neighboring States, the beetles often occurring in swarms like blister beetles. This species resembles the elm leaf-beetle, but is larger and differently marked. It is oblong, narrow in front and dull brown while the wing-covers are more or less distinctly striped.

The Western Beet Beetle (*Monoxia consputa* Lec.).—Beets are much injured by this species along the Pacific Coast. It

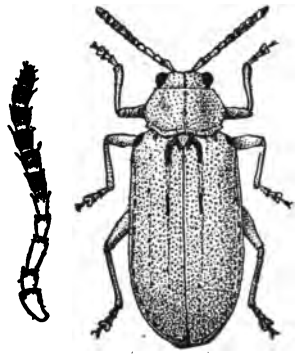

Fig. 77.—Western beet beetle. Eight times natural size; antenna at left highly magnified. (Author's illustration, U. S. Dept. Agr.)

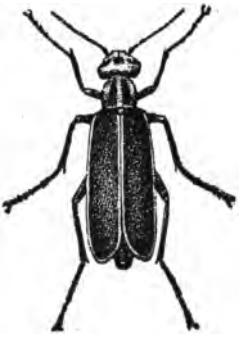

Fig. 78.—Margined blister beetle. Enlarged. (Author's illustration, U. S. Dept. Agr.)

eats holes through the leaves, in some instances leaving only a network of the original leaf, and this seriously interferes with the growth of young plants, which are sometimes killed. This beetle (fig. 77) is closely related to the preceding, but is smaller, measuring only about one-sixth of an inch in length.

Remedies.—These beet leaf-beetles are important enemies of sugar-beet culture. The general methods for the control of leaf and flea-beetles (see page 65) are applicable, but a few remarks should be added in regard to particular remedies. Paris green, London purple, and paragrene have all been employed against the larger species with apparently good results when applied

dry, mixed with flour, in the same manner as for the Colorado potato beetle. The beetles accumulate quite largely upon "mother" beets early in spring, which suggests that if a few beets be left in the ground over winter they will serve as trap crops for the protection of the younger plants in spring. The larger species practically confines its injuries to plants growing in or in close proximity to alkali soil. Hence such ground is to be avoided for the cultivation of beets.

BLISTER BEETLES

Blister beetles are among the most conspicuous of all beet enemies, and no less than 11 species have been observed as doing injury to sugar-beet alone. One of the commonest is the margined blister beetle (*Epicauta marginata,* fig. 78). The writer has seen entire plantings of beet almost completely defoliated by it; but as a rule this and several of the other beet-feeding blister beetles occur too late in the season to do material harm, as the roots have by this time made nearly complete growth. This species also attacks beans, potatoes and tomatoes, as well as other vegetables, and is destructive to some flowering plants. It is most abundant in July and August.

REMEDIES are the same as for other blister beetles (page 68).

CUTWORMS AND OTHER CATERPILLARS

When sugar-beets are cultivated over a large territory, there is comparatively little danger of injury from common cutworms which are such serious pests in the vegetable garden. Certain species, however, occur occasionally in great numbers, spreading from field to field, like the army worms, and sometimes sweep everything before them, as they feed upon every portion of the plant—foliage, flowers, stalks, and even roots. At such times they should be promptly destroyed. Methods of control employed against cutworms are considered on page 54. When traveling in armies cutworms should be treated as army worms (see p. 58).

The Beet Army Worm (*Laphygma exigua* Hbn.).—This species has come into prominence since the extensive cultivation of the sugar-beet in the West. It is rapidly widening in distribution, chiefly by the flight of the mature insect, a moth resembling the parents of the cutworms. This insect might be a still more injurious sugar-beet pest than is yet known, save for the fact that it attacks many other crops and weeds.

The moth (fig. 79, *a*) is of a gray color, resembling the plain form of the fall army worm, to which species it is related. The

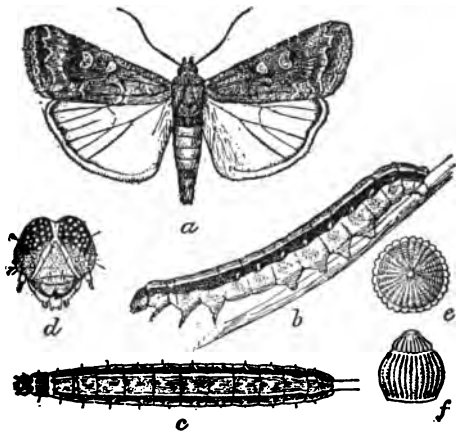

Fig. 79.—Beet army worm. *a*, Moth; *b*, larva, lateral view; *c*, larva, dorsal view: *a*, head of larva; *e*, egg, viewed from above; *f*, egg, from side. All enlarged. (Author's illustration, U. S. Dept. Agr.)

fore-wings are broader and paler, and the reniform and other spots as well as mottlings are more distinct. The wing expanse is less than an inch and one-half. The larva is striped, as shown at *b* and *c*.

Remedies.—When occurring in numbers this insect can be controlled by means of an arsenical, but when unduly abundant, army worm remedies are necessary.

The Beet Webworm (*Loxostege sticticalis* Linn.).—This insect is, like the preceding, of foreign origin, and is also rapidly

increasing its range, and as it has developed an unusual fondness for sugar-beet it will in time become a beet pest of great importance. It has evidently been introduced on the Pacific Coast and has been found destructive as far eastward as Michigan and Nebraska, and has done considerable injury in other localities, including Canada where it was recently very destructive. It is cousin to the native garden webworm, which it resembles in general form. It is, however, darker and about

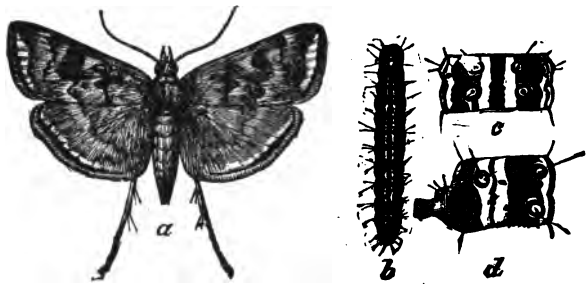

Fig. 80.—Beet webworm. *a*, Moth, twice natural size; *b*, larva, less enlarged; *c*, upper surface of first proleg segment of larva; *d*, side view of same; *c*, *d*, more enlarged. (After Insect Life.)

one-fourth larger. Fully expanded the wings measure nearly an inch, and are purplish brown in color, with darker and paler bands, as shown (fig. 80, *a*). The hibernating caterpillars make a burrow beneath the surface of the ground and construct a cocoon about three times as long as themselves. A similar but shorter cocoon is made by the midsummer brood.

A favorite wild food plant of this species has been observed —the pigweed or careless weed (Amaranthus)—and injury to sugar-beet has been observed in many cases where the ground was allowed to run to the wild plant.

Remedies.—The destruction of this and other weeds might in time lead to comparative immunity from the attack of the webworm. Paris green or other arsenical sprayed several times over the infested plants will also compass its destruction.

Other kinds of caterpillars, including such well-known forms as the zebra and salt-marsh caterpillars, are often found in beet fields, but seldom in sufficient numbers to do serious injury. As a rule they readily yield to sprays of Paris green.

GRASSHOPPERS

Grasshoppers, or locusts, as well as crickets and some related insects, are of great importance in the West, and frequently do injury to sugar-beets. Many species attack this plant.

REMEDIES.—The hopper-dozer is a necessary implement in our warfare against this class of pests. It is discussed with other grasshopper remedies on page 71.

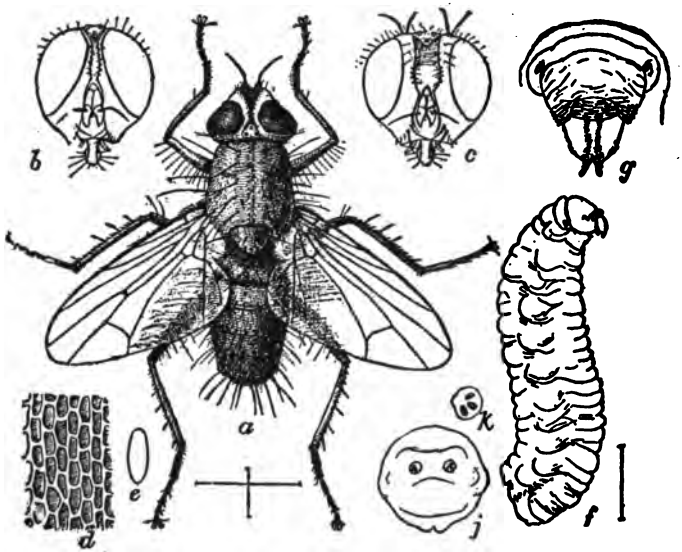

Fig. 81.—Beet leaf-miner. *a*, Fly; *b*, head of male fly; *c*, head of female; *d*, surface of egg, highly magnified; *e*, egg; *f*, maggot; *g*, head of same; *j*, anal segment; *k*, anal spiracles. All enlarged. (After Howard, U. S. Dept. Agr.)

LEAF-MINERS

Hitherto insects which affect chiefly the foliage by chewing have been treated. We now come to a consideration of insects

of different habits, and among these are the leaf-miners—small, white maggots producing two-winged flies resembling the house fly. These burrow between the two surfaces of the leaves and form blotches termed mines. The principal species, the beet or spinach leaf-miner (*Pegomya vicina* Lint.), is illustrated (fig. 81). We have not as yet ascertained any perfectly satisfactory remedy for the leaf-miners.

PLANT-BUGS, LEAFHOPPERS AND APHIDES

Hordes of sucking insects, many plant-bugs, leafhoppers and numerous related forms are present in fields of sugar-beet at all times, and sometimes accomplish very considerable injury. Among the most prominent of these are the false chinch-bugs.

The most satisfactory manner of keeping false chinch-bugs in check is by clean farming methods, destroying purslane and other weeds, and the cleaning up of crop remnants before winter, so as to leave no place for the insects to pass the winter. Some growers have observed that the flooding of fields infested by these insects forces them to leave, and the growing of mustard as a trap crop gives good results, provided the precaution is always taken to destroy the mustard before it runs to seed.

The sugar-beet leafhopper (*Eutettix tenella* Baker) came into prominence as a beet pest in Utah, Idaho and Colorado in 1905, doing damage that year estimated at $500,000. This insect has become locally known as "white fly" and its injury as "blight." It has been noticed that late-planted beets are principally damaged and that early plants are less injured, and it may be that on this or a similar point in its life economy may hinge the remedy. It is worthy of remark that the species was unknown to science until 1900.

For the aphides which attack sugar-beet, it is sometimes un-

necessary to employ remedies, as these creatures are peculiarly susceptible to atmospheric conditions, doing their greatest injury in cool, damp weather, and being held in nearly complete abeyance at times by numerous natural enemies which flourish in dry and even hot weather, as is very well known. In gardens of table beets, kerosene emulsion, pyrethrum and fumigation, according to directions given on page 165, are of value. Practically none of these remedies can be employed on large fields, but are useful in small ones. Clean farming and fall plowing are always advisable, and crop rotation should be practiced where possible with potatoes or similar crop.

Two species of root-aphides do great damage. They are the beet aphis and beet root-aphis.

The Beet Aphis (*Pemphigus betæ* Doane) ruined in one year in a single valley upwards of 1,000 tons of beets. This was in Oregon. The species also inhabits Washington, and probably California, and it is probable that it may be reckoned among the important beet pests of the future.

Owing to the large acreage in sugar-beet growing regions of the United States we cannot successfully control the root-aphides by means of insecticides. It would be supposed naturally that heavy flooding and plowing in fall so as to expose the insects to the frost might control it, but this is sometimes a failure. Our knowledge of alternate food plants is somewhat limited, but we can recommend the avoidance of beet cultivation in land where other plants subject to the attack of this insect have grown; also crop rotation. If the aphides are found at work only in parts of a field, they could be destroyed here with kerosene emulsion applied preferably just before rainfall, or by following the application with a flooding of water.

Root-aphides are almost invariably associated with ants, which foster them and act as distributers of infestation by carrying wingless forms from plant to plant. It is therefore advisable to break up the nests of ants as fast as they are found.

The Beet Root-aphis (*Tychea brevicornis* Hart, fig. 82) is most destructive in Colorado. It has a variety of alternate food plants, and we can only learn by experiment what are the best for rotation. We should avoid corn, sorghum, and other cereals, grasses, and particularly should we avoid weeds, including wild grasses. Otherwise the remedies advised for the beet-aphis are suggested.

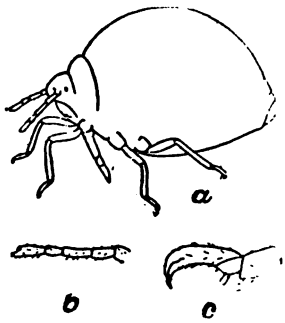

Fig. 82.—*a*, Bean root-aphis; *b*, antenna; *c*, tarsus. Enlarged. (After Garman.)

WHITE GRUBS AND WIREWORMS

A number of forms of white-grubs and of wireworms attack beet roots, but none appear to favor this form of food. We have yet to learn of severe and extensive damage by them.

REMEDIES.—Among the best remedies are fall plowing, rotation of crops, clean cultivation, in particular the suppression of grasses, the use of potash fertilizers as stimulants to the plants found affected, all of these remedies acting to a certain extent on both forms of insects.

In this chapter there have been considered quite briefly the principal forms of insects which trouble the beet-grower or which he may expect to meet in his fields. Several of the insects mentioned in the last four pages require additional investigation before definite and detailed instructions can be furnished for their suppression. For further information application should be made to the Bureau of Entomology of the Department of Agriculture.

CHAPTER IX

INSECTS INJURIOUS TO CABBAGE AND OTHER CRUCIFEROUS CROPS

CABBAGE is peculiarly susceptible to insect attack, and there are probably more species of insects that injure it than any other truck crop. Other edible cole plants are attacked by the same species of insects, but as a rule suffer rather less injury. Attack begins from the time the seeds commence to sprout and continues in the case of cabbage until the edible product is ready for cooking.

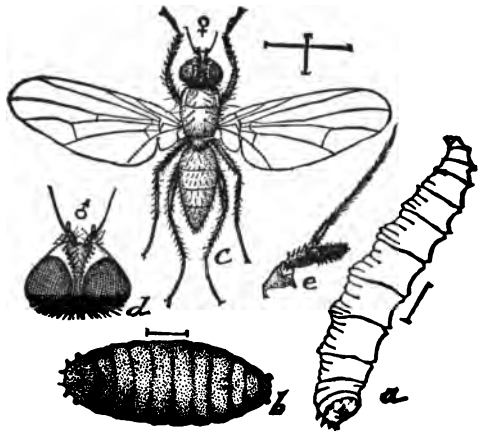

Fig. 83.—Cabbage root-maggot. *a* Larva; *b*, puparium, dorsal view; *c*, female fly; *d*, head of male; *e*, antenna. All enlarged. After Riley, U. S. Dept. Agr.)

ROOT-MAGGOTS

The Cabbage Maggot (*Pegomya brassicæ* Bouché).—The roots of cabbage and related cruciferous crop plants frequently suffer severe injury from the attack of the cabbage maggot (fig. 83). Young plants are most seriously affected, the mag-

gots eroding the outer surface and boring into the interior of the roots, devouring the tender rootlets and frequently penetrating into the lower portion of the stalk. This insect, known also as radish maggot, is an imported pest. It does serious injury throughout the northern tier of States and Canada, attacking all forms of crucifers. It is the cause of more or less loss to these crops each year. Since 1902 it has not only been exceedingly destructive, but has increased in injuriousness from year to year. Frequently entire crops over considerable areas are completely destroyed. Two or three generations of this maggot are indicated where it has been observed.

REMEDIES

The remedies prescribed for the seed-corn maggot are applicable. In addition there are certain preventive and other measures for its destruction that have been found successful, their use being justified by the great value of cabbage plants.

Carbolic-acid emulsion, prepared as prescribed on page 37, and diluted about 35 times, is applicable when this maggot occurs on radish.

Hand-picking, although laborious, has the merit of effectiveness, and is useful on cabbage, although not practicable on radish and similar crops. It consists in pulling up the young plants, examining the roots for eggs and maggots, and either destroying the eggs and maggots by crushing with the hand or by washing the roots in a strong solution of soap and then replanting. In most cases the plants show no ill effects from this treatment after two or three weeks have elapsed.

Methods of cultivation.—Comparatively little can be expected from various farming methods which are safeguards against other insects. Keeping the soil well hilled around the cabbage plants develops more roots, thus affording more food for the maggots and leaving enough roots to strengthen the plant itself. Crop rotation should be followed with any plants other than

crucifers or onions. With these latter it is inadvisable, as the same atmospheric or other conditions which induce injury by the cabbage maggot seem to operate in increasing the numbers of the onion pest, which has a similar distribution. Fall plowing is advisable and cabbage stumps should be removed and destroyed, especially early in the season.

Bisulphid of carbon treatment.—In case tarred paper cards, which will next be described, or other preventive methods are not employed, bisulphid of carbon may be used. It should be

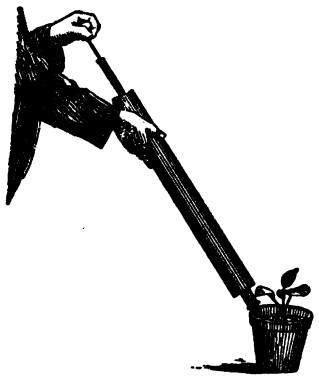

Fig. 84.—Bisulphid of carbon injector in use

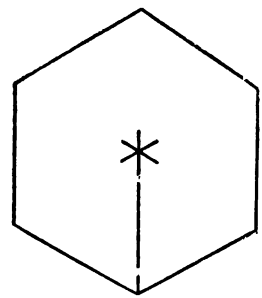

Fig. 85.—Tarred paper card in outline. One-half size. (After Goff.)

applied below the root system with a special injector or syringe,[1] taking care that the application is not made directly to the plants, as it is likely to kill them. A hole is made a little distance (3 or 4 inches) from the plant, and the injector inserted at an angle, as shown in figure 84. After injecting the liquid the instrument should be withdrawn and the hole closed by packing with the foot. From a teaspoonful to a tablespoonful to each young plant, and a single application, is generally sufficient.

Tarred paper cards.—The use of disks or pads of tarred paper

[1] The McGowen injector, no longer for sale, has proved very successful.

for the protection of cabbage against the oviposition of the fly was perfected in 1889 by Mr. W. H. Goff.

The cards are cut in hexagonal form (fig. 85), in order to economize material, and a thin grade of tarred paper is used, as the cards made from it are more readily placed about the plant without being torn. The blade of the tool, which can be made by a blacksmith, is formed from a band of steel, bent in the form of a half hexagon, and then taking an acute angle, reaches nearly to the center, as shown in figure 86. The part making the star-shaped cut is formed from a separate piece of steel, so attached to the handle as to make a close joint with the blade. The latter is beveled from the outside all around, so that by removing the part making the star-shaped cut the edge may be ground on a grindstone. It is important that the angles in the blade be perfect, and that its outline represent an exact half hexagon.

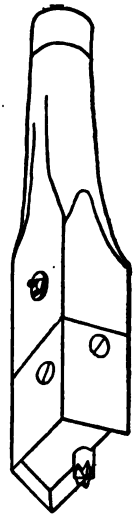

Fig. 86.—Tool for cutting cards. About one-fourth size. (After Goff.)

To use the tool, place the tarred paper on the end of a section of wood and first cut the lower edge into notches, as indicated in figure 87, using only one angle of the tool. Commence at the left side, and place the blade as indicated by the dotted lines, and strike at the end of the handle with a light mallet, and a complete card is made. Continue in this manner across the

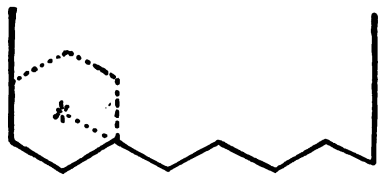

Fig. 87.—Showing how tool is used, dotted line indicating position of edge of tool. (After Goff)

paper. The first cut of every alternate course will make an imperfect card, and the last cut in any course may be imperfect, but the other cuts will make perfect cards if the tool is correctly made and properly used. The cards should be placed about the plants at the time of transplanting. To place the card, bend it slightly, to open the slit, then slip it on the center, the stem entering the slit, after which spread the card out flat, and press the points formed by the star-shaped cut snugly around the stem.

A Wisconsin grower protected 7,000 plants and secured a splendid crop, while unprotected plants nearby would have been a complete failure if the maggots had not been picked off by hand. Others have reported similar success. One lost only 25 plants out of 10,000 to 15,000 that he protected with the cards, where ordinarily he would have lost from 75 to 90 per cent. of the crop.

The tarred cards are applicable to cabbage and cauliflower only, but it is claimed by those who have employed them that they are cheaper, more practicable, and more efficient than anything as yet devised for preventing the ravages of the cabbage maggot. Success in using them is dependent upon their being properly applied, *to fit tightly,* so that the fly is unable to obtain access to the stem for the deposition of her eggs. Cards must be renewed and their use continued for each maggot year to be effective.

Coverings and hellebore.—Some success has also been attained by covering young plants in seed-beds with netting and by applying hellebore about the roots.

The Seed-corn Maggot (*Pegomya fusciceps* Zett.).—This species, previously considered on page 106 on bean and pea insects has been identified with attack to cabbage, turnip and radish on numerous occasions and in many localities. When occurring on such plants it should be treated in about the same method as the cabbage maggot.

CABBAGE WORMS

The Imported Cabbage Worm (*Pontia rapæ* Linn.).—This is the worst of all cabbage pests and one of the most important of all truck insects. It is altogether too well known through-

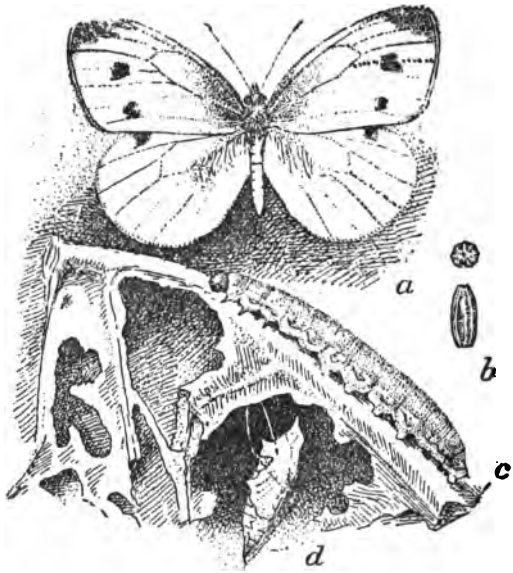

Fig. 88.—*Pontia rapæ*. *a*, Female butterfly; *b*, egg; *c*, larva on cabbage leaf; *d*, suspended chrysalis. *a*, *c*, *d*, Slightly enlarged; *b*, more enlarged. (Author's illustration, U. S. Dept. Agr.)

out North America and Europe, and the white butterfly is quite generally recognized as its parent. The caterpillar is velvety green and measures, when full grown, about an inch and a quarter, presenting the appearance shown in figure 88, *c*. The butterfly has a wing expanse of nearly two inches, and is white, marked with black near the tips of the fore-wings. The female (*a*) has two conspicuous black spots on each fore-wing, the male has only one. This cabbage worm is the bane of every cabbage-grower, and the dread of every

careful cook and housewife. It begins work early in the season, when the principal damage is usually accomplished, and after riddling the outer leaves, attacks the more tender inner leaves as they form, frequently secreting itself in the heads, which are made most unsightly by its excrement. This species was first observed in the United States in 1865 and in about a score of years it had invaded nearly every state and territory in our domains.

All cruciferous crops, but particularly cabbage and cauliflower, are attacked, as are also nasturtium, mignonette and some allied plants. The butterflies are on the wing from early morn till dusk. As early as March they can be seen flying about cabbage fields and they continue until after severe frosts. The observed egg period is from 4 to 8 days. The larva eats voraciously and grows with rapidity, attaining full growth in from 10 to 14 days after hatching. The summer-time chrysalis period is from 7 to 14 days, but the last chrysalides remain undeveloped until the following spring. The life cycle has been traced from between 22 days to five weeks. Even in New England this species is credited with being triple brooded, but in the District of Columbia and vicinity there must be one or more additional generations, and there is a possibility of still more in the extreme South.

A natural enemy of this species, *Pteromalus puparum,* is shown in figure 89, and a "worm" parasitized by *Apanteles glomeratus* is illustrated by figure 90.

REMEDIES

In treating this species it should be borne in mind that other "worms" and pests are more often present than otherwise.

Arsenicals.—The best remedy is Paris green applied, preferably as a spray, at the rate of about one pound of poison to 150 gallons or less of water, and it should be used when plants are first set out, to insure its reaching the young "worms" be-

fore they have burrowed far into the heads. Other applications should follow frequently, as required, and can be made with safety until the heads are about half formed, and even later, as the poison, under ordinary circumstances, disappears from the plants two or three weeks after being applied.

Bran mash is, according to the testimony of some, successful against cabbage worms. It is prepared in the same manner as for cutworms and grasshoppers. See page 55.

Kerosene emulsion is not as efficient as arsenicals, because

Fig. 89.—*Pteromalus puparum*. Female. Highly magnified. (Author's illustration, U. S. Dept. Agr.)

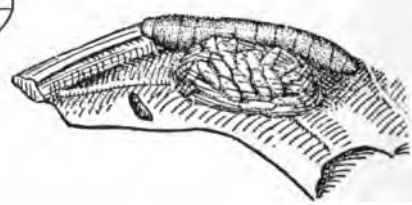

Fig. 90.—Parasitized cabbage worm (*Pontia rapæ*), showing cocoon mass of *Apanteles glomeratus* below. (Author, U. S. Dept. Agr.)

it is necessary for this spray to come into direct contact with the "worms."

Pyrethrum has the advantage of not being poisonous to humans, but is said by some cabbage growers to discolor the leaves, and if its use is not continued at frequent intervals the "worms" recover. It is more expensive than remedies that have been mentioned.

Hot water at a temperature of about 130° F. does practically no harm to plants and destroys all insects with which it comes in contact.

Clean cultivation and trap crops.—If united effort in clean farming could be secured, together with the use of arsenicals, the losses due to the ravages of this and other leaf-feeding cabbage pests might be largely averted. The practice of leaving

cabbage stalks in the field after the crop has been secured is reprehensible. Remnants should be destroyed, with the exception of a few left at intervals through a field as traps for the females for the deposition of their eggs. These plants should be freely poisoned with arsenicals, so that the last generation will not develop.

The Southern Cabbage Butterfly (*Pontia protodice* Boisd.).—Before the advent of the imported cabbage butterfly, the present species was the occasion of considerable injury, particularly

Fig. 91.—Southern cabbage butterfly worm. (After Riley)

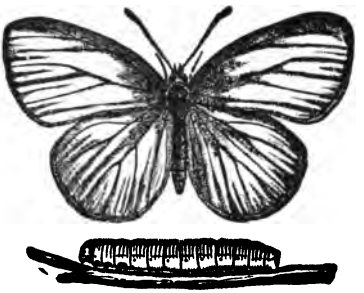

Fig. 92.—Potherb butterfly. Adult above, larva below. (After Harris)

southward. Of late it has disappeared in many regions, but occasionally makes its reappearance for a limited period. In many respects it resembles the preceding, and the male as it is seen flitting lazily through cabbage fields and gardens would never be recognized as distinct from the more injurious form. The "worm" (fig. 91) varies from pale to dark blue or green, is striped with yellow and covered with black spots bearing black hairs.

REMEDIES.—The treatment is the same as for the preceding.

The Potherb Butterfly (*Pontia napi* Linn.).—This butterfly is found in the more northern and eastern portions of North America, and is distinguished from others attacking cole crops by its nearly uniform white wings without spots. The larva (fig. 92) is uniform pale green, and resembles the cab-

bage leaves on which it feeds. It devours the pulp on the lower surface, often leaving the veins intact.

This species has evidently been decimated in the same manner as the southern cabbage butterfly by the foreign invader, *Pontia rapæ,* and is now seldom found save on wild plants.

REMEDIES are the same as for the imported cabbage butterfly.

The Cross-striped Cabbage Worm (*Evergestis rimosalis* Guen.).—Thus far have been considered only the "worms" produced by butterflies. The species figured and those which

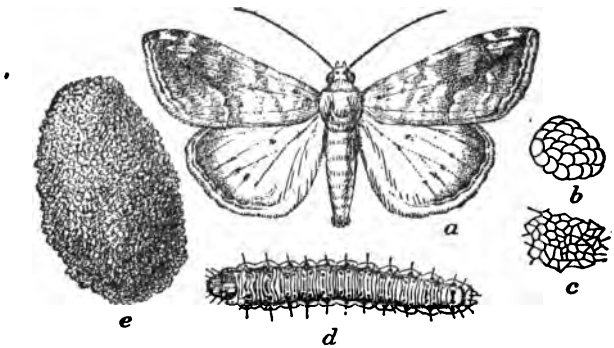

Fig. 93.—Cross-striped cabbage worm. *a*, Moth; *b*, egg mass; *c*, sculpture of egg; *d*, "worm"; *e*, cocoon. *a*, *d*, *e*, Twice natural size; *b*, *c*, more enlarged. (Author's illustration, U. S. Dept. Agr.)

follow are all the progeny of moths. This "worm" injures cabbage and its varieties in nearly the same manner as does the imported cabbage worm, attacking the heads and digging deeply into, and eating out, the hearts. While plants are tender this destroys them for the market or table. This species is as a rule less injurious to other crucifers (fig. 93).

REMEDIES.—The remedies advised as best for the imported cabbage worm are equally applicable to this species.

The Common Cabbage Looper (*Autographa brassicæ* Riley).—Late cabbage particularly southward is much subject to injury by the looper or cabbage "plusia" which is, next to the imported

cabbage worm and the harlequin bug, our most important insect enemy of cruciferous crops. It is unusually voracious, developing rapidly, but is kept under partial control by natural influences, and therefore subject to extreme fluctuation in numbers, doing great damage for one or more seasons in some localities, and remaining absent from them for a number of succeeding years.

The insect derives its name from the peculiar habit of its larva of "looping" like a measuring worm, due to the lack of legs on the third and fourth joints of the abdomen. The moth which produces it is shown in figure 9, *a*. The "looper" is at first a pale-green, fragile-looking creature, and varies in color when mature, being strongly marked with white lines, shown in figure 9, *c*. It constructs for pupation a white, gauzy cocoon, *d*, which is usually attached to the broad surface of a leaf. The cabbage looper is well distributed throughout that part of the United States lying east of the Rocky Mountains, and is more destructive in the South than in the northern States. It is most troublesome to cabbage, but affects all crucifers and at times does great injury to peas, beets, celery and lettuce, and feeds also on tomato, potato and less frequently on asparagus and clover. It sometimes does damage to carnation, mignonette, and German ivy in greenhouses.

The species is apparently three-brooded on Long Island and in the District of Columbia, and hibernation takes place chiefly in the pupal stage. Few individuals survive the winter northward, but the propagation of the species is so rapid that by the time autumn is reached great numbers of loopers are produced which do much damage to crops in cultivation at this time. This insect is very susceptible to diseases and to parasitism. A parasitized looper is shown by figure 94.

Methods of Control employed for other cabbage worms are useful against loopers. Remedial measures should be continued with persistency at frequent intervals in order to insure suc-

cess, and arsenicals should be applied when possible to the lower surface of the outer leaves to destroy all the insects. If the first generations could be killed off there would be less difficulty in keeping the insect in subjection. Paris green mixed with lime or other diluent has been used dry with some success, but is less efficient than for the imported cabbage worm. Dry applications do not reach the lower surface, hence a spray is preferable. The larger loopers eat through the leaves, but when they find anything distasteful they cease feeding and search for tissue that has not been poisoned. After rainfall eggs hatch and the poison having been washed away the larvæ continue feeding. Sirrine obtains good results with resin-lime mixture. It requires about two hours to make this mixture, and considerable

Fig. 94.—Cabbage looper parasitized by *Copidosoma truncatella* Slightly enlarged (After Riley, U. S. Dept. Agr.)

care is necessary in its preparation; but when crops are grown on a large scale it might pay to use this remedy. It has the advantage of being more adhesive than a Paris green spray, remaining on the under surfaces as well as upper leaves and requiring two or three heavy rains to remove all of it, even on the exposed portions of leaves. Arsenate of lead has similar adhesiveness, and as it has given good results in experiments on a small scale it should receive further tests.

The Imported Cabbage Webworm (*Hellula undalis* Fab.).—As if the cabbage-grower did not have enough "worms" with which to contend a new species has recently appeared in the South, and there is now the threatened danger of its introduction farther north in the same manner as has happened in the

case of the cabbage looper and harlequin cabbage bug. The species under consideration, the imported cabbage webworm, should it increase in destructiveness and enlarge its area, bids fair to become a troublesome species, as it is difficult to treat.

The moth (fig. 95, *a*) is gray, with the fore-wings mottled with black, white and brown. The expanse of wing is about

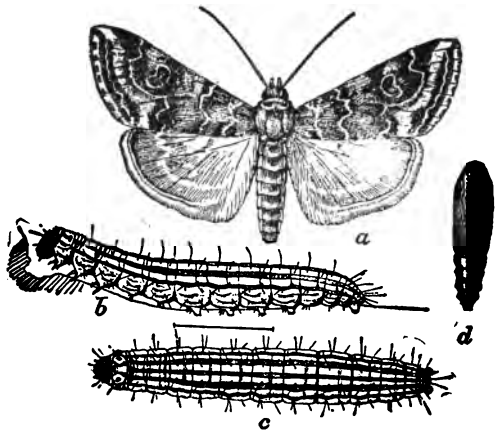

Fig. 95.—Cabbage webworm. *a*, Mature moth; *b* larva, lateral view; *c*, larva, dorsal view; *d*, pupa All three times natural size. (Author's illustration, U. S. Dept. Agr.)

five-eighths of an inch. The mature larva (fig. 95, *b, c*) is a little more than half an inch long, in color dull yellowish-gray, striped with broad, brownish-purple longitudinal bands. The moth is described as laying her eggs in the "bud" of cabbage, or turnip, and the larva soon after hatching spins a web over itself, leaving a hole for egress. From the protection afforded by this domicile the larva feeds, retiring into the web when its hunger is appeased. When larvæ are particularly numerous three or four days suffice for the destruction of a turnip or cabbage patch, the plants rotting, or in the case of turnip failing to develop roots, and this with their excrement which adheres

to the plants, forms a more or less perfect place of concealment for them.

REMEDIAL MEASURES.—A spray of Paris green applied as soon as the larva hatches serves in great measure to control it. Clean cultural methods should be persistently practiced, and every bit of refuse material, particularly cabbage stalks and weeds, should be raked up into piles and set afire by adding, if necessary, dry straw to aid in their ignition. Kerosene emulsion, properly prepared and applied sufficiently often to insure a permanent odor, should be effective in preventing egg laying and will also destroy other insects with which it may come in contact.

The Diamond-back Moth (*Plutella maculipennis* Curtis).—One of the minor enemies of cabbage is the larva of the imported diamond-back moth or "cabbage plutella." It is smaller than any of the preceding, and as a rule its injuries are much less conspicuous. Occasionally, however, it becomes sufficiently numerous as to be quite troublesome. Its minute active caterpillar may be found on cabbage everywhere, and in this stage as well as in pupa, when it rests in a beautiful white, lace-like cocoon attached to the surface of cabbage leaves, it is familiar to observing persons. Attack is usually confined to the outer leaves, the larva feeding generally on the lower surface and not eating through, as with the larger looper and some other worms. At times, however, leaves are riddled with holes and much of their substance devoured.

The moth (fig. 96, *f*) is gray and distinguished by the black-marked fore-wing. The wing expanse is about three-fifths of an inch. This insect is found during winter on old cabbage stalks, hibernation taking place normally as pupa, although adults also occur as late as December. Two or three generations are produced in the more northern States, and farther south four or five broods occur during a season. In the extreme South the insect occurs throughout the year.

REMEDIES.—The simpler cabbage worm remedies are sufficient in ordinary cases. Pyrethrum is valuable as is also kerosene emulsion, but Paris green, unless applied as an underspray, which is difficult with most cruciferous crops, is reported not so effective.

Cutworms will attack cabbage, turnip, and similar plants when available, and there are a number of caterpillars, other than those which have been considered, which do great damage

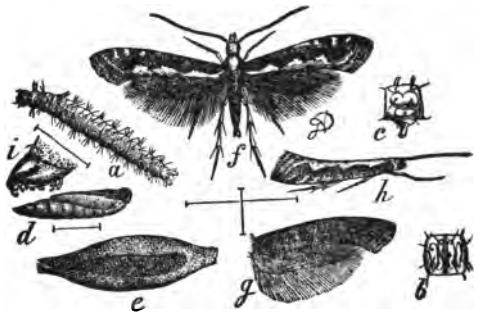

Fig. 96.—Diamond-back moth. *a*, Larva; *b*, *c*, segments of same; d, pupa; *e*, pupa in cocoon; *f*, *h*, moth; *g*, wings of dark form of moth; *i*, last segment of pupa. All enlarged. (After Riley, U. S. Dept. Agr.)

to these crops. When cutworms become abundant late in the season, plants are damaged in the same manner as by the imported cabbage worm, by eating the more tender portions and penetrating into the hearts. Severe injury is often reported, *e. g.*, in one garden only 30 plants out of 600 escaped, while it is not uncommon to lose half or more of the plants early in the spring. The fall army worm, salt-marsh caterpillar and "woolly bears" frequently attack cole crops, and the first mentioned when numerous does damage of great seriousness. The zebra and clover caterpillars appear to favor these crops among others grown in gardens, and the garden webworm also affects them. These species are treated in preceding chapters.

FLEA-BEETLES AND LEAF-BEETLES

An unusual number of flea-beetles are reckoned among enemies of cruciferous crops. No less than seven species (of *Phyllotreta*) are more or less attached to this class of plants and although like other flea-beetles they are as a rule only periodically troublesome, they are in their abundant seasons foes of no little importance. The characteristics of flea-beetles have been described on page 63. The cabbage-feeding forms are mostly quite minute, none measuring more than an eighth of an inch.

The Striped Turnip Flea-beetle (*Phyllotreta vittata* Fab.).—The commonest and most destructive flea-beetle living on cruciferous crops is the species above mentioned. It is found throughout the warmer months, and attacks most crucifers, cultivated and wild. As it is subject to great fluctuation in numbers, it cannot be compared to the imported cabbage looper or harlequin bug, yet it is capable of severe injuries and cruciferous crops are seldom free from it within its range, which is extensive. The beetle (fig. 97, *b*) is polished black in color, and each wing-cover is ornamented with a broad, wavy band of pale yellow.

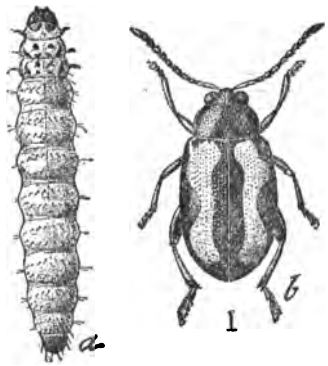

Fig. 97.—Striped turnip beetle. *a*, larva; *b*, beetle. (Riley, U. S. Dept. Agr.)

This species is indigenous to the Atlantic region, where it is most abundant, but has been diffused by commerce, until now it is found in most States and Territories from Maine to the Gulf and Pacific States.

REMEDIES.—When cabbage and other crucifers are treated with arsenicals for "worms" no further remedy is necessary

for flea-beetles. It adds to the effectiveness of Paris green, however, to use Bordeaux mixture as a diluent, as the latter in addition to being a fungicide is a powerful deterrent of

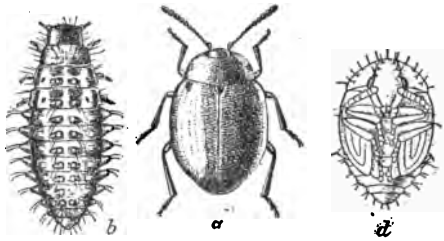

Fig. 98.—Water-cress leaf-beetle (*Phædon æruginosa*). *a*, Adult; *b*, larva; *d*, pupa Enlarged six times. (Author's illustration, U. S. Dept. Agr.)

flea-beetles. See page 65 on remedies for leaf-beetles and flea-beetles.

The Water-cress Leaf-beetle *(Phædon æruginosa* Suffr.) has been reported injurious to water-cress since 1903. It is a small, metallic blackish beetle (fig. 98) and with the water-cress sowbug (figured on page 4) is a pest on the plant from which they have both received their English name.[1]

Fig. 99.—Western cabbage flea-beetle. Much enlarged. (After Riley, U. S. Dept. Agr.)

The Western Cabbage Flea-beetle (*Phyllotreta pusilla* Horn.).—In some of the western States not yet inhabited by either of the preceding there is a smaller, dark-colored flea-beetle which sometimes does great damage to crucifers and many other crops.

This flea-beetle is of a uniform deep polished olive-green color, and the surface is irregularly punctate. It measures about seven-hundredths of an inch in length. It ranges from the Dakotas to Mexico, and westward to Southern California and is often found in great numbers.

[1] Information concerning both species is furnished in Bul. No. 66, Pt. II, Bu. Entom., U. S. Dept. Agr.

REMEDIES.—Owing to the peculiarity of this species of congregating in immense numbers and doing great damage in a short time, immediate steps for its suppression must be taken. Remedies advised for the striped turnip flea-beetle are applicable.

PLANT-BUGS AND APHIDES

The Harlequin Cabbage Bug (*Murgantia histrionica* Hahn.).—From southern New York and Ohio southward, late cabbage and other cole crops sometimes suffer severely from a gayly colored plant-bug variously known as the calico back, fire bug,

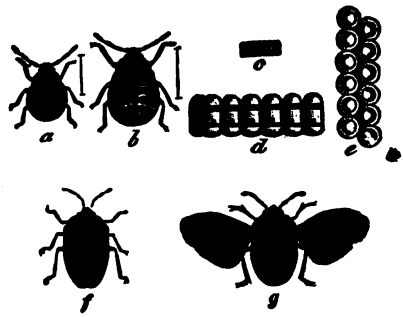

Fig. 100.—Harlequin cabbage bug. *a*, Young; *b*, half grown; *c*, *d*, egg cluster; *e*, same from above; *f*, *g*, adult. *c*, *f*, *g*, Natural size; *a*, *b*, slightly enlarged; *d*, *e*, more enlarged. (After Riley.)

and terrapin bug, as well as harlequin cabbage bug. It is the most destructive cabbage pest of the South, and second only to the imported cabbage worm as an enemy to the cole crops of our country. It is a native of Mexico and Central America and since its discovery in Texas in 1866 its dissemination northward and eastward has been rapid, until at one time it threatened to overrun southern portions of New York and New England, Ohio and States farther westward. The harlequin-like ornamentation of the insect is shown in figure 100, *f*. *g*.; the dark portions are shining black or dark blue and the lighter portions

bright yellow or red. The eggs *(d)* are beautiful objects, looking like miniature white barrels bound with black hoops, and with black spots set in the proper place for bung-holes.

This insect accomplishes its work of destruction by sucking the sap from leaves and veins of cabbage and other crucifers, the affected leaves wilting, withering and dying as if fire-swept—whence the name "fire bug." Half a dozen mature insects suffice to destroy a small plant in a day. This is a pest which, if permitted to have its own way, is almost certain to destroy a portion, and if sufficiently numerous, all of the fields which it infests, and the writer has seen in the vicinity of the District of Columbia, in Maryland and Virginia many fields in successive years from which not a single good cabbage could be cut, and has observed equal injury to horseradish and some other crucifers. Toward the end of the season and in early winter the mature bugs are still afield, seeming loath to seek shelter from the cold. When cruciferous crops have become exhausted they attack almost any form of vegetation.

PREVENTIVE AND REMEDIAL MEASURES.—The difficulty of destroying this insect with contact poisons such as kerosene-soap emulsion, which are practically inert against the adults and only partially effective on the youngest nymphs, necessitates the use of preventives to compass this end. The most important is clean farm practice. The practice of leaving cabbage stalks and other cruciferous plants in the field late in autumn and early winter, or of allowing cruciferous weeds to grow up, or, in fact, allowing any sort of debris to accumulate, serves to protract the life of this insect by affording it food or quarters for protection against the cold. It is inadvisable to plant crucifers in the vicinity of outhouses and barns, as the bugs use such places for passing the winter.

Some of the insect's food plants may be left, after cropping, at intervals throughout fields to attract the bugs in the fall, and here they may be killed with crude kerosene, by mechanical

methods, or piles of rubbish may be left to attract them where they can be burned.

The best remedy, however, and one that should be put into operation by every southern cabbage grower, is the planting of an early crop of mustard, radish, rape, or kale as a lure for the first appearing bugs. Overwintered bugs appear from March to May. They appear to prefer for the first deposition of their eggs the plants that have been mentioned, though cabbage may be available. On these the insects are killed by kerosene or by hand, as, for example, by capture with a hand net, or by burning the traps when these are of no value as

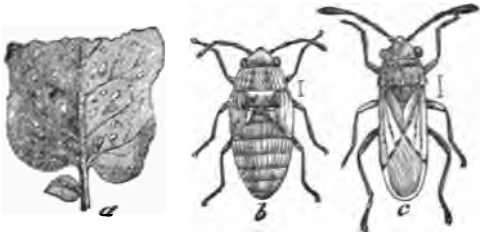

Fig. 101.—False chinch-bug. *a*, Leaf showing punctures; *b*, last nymph stage. *c*, adult. *a*, Natural size; *b*, *c*, much enlarged. (After Riley)

food. If the first generation is generally done away with, few insects fly from other quarters, and injury is largely prevented for an entire season.

The False Chinch-bug *(Nysius angustatus* Uhl.).—The false chinch-bug, although a general feeder, appears to be somewhat more attached to turnip, cabbage and similar crops, but also injuriously affects potato, beets, lettuce, the vine, apple, grass and strawberry. It derives its name of false chinch-bug from its being frequently mistaken for the true chinch-bug, to which indeed it is related. The adult is grayish brown and of the appearance shown in figure 101, *c*. The hemelytra or wing-covers are more or less transparent. The length is about one-eighth of an inch. In distribution it extends from New

Hampshire to the Gulf, and westward to the Pacific States. At *a* of figure 101 is represented the appearance of a leaf of potato showing the minute, rusty circular specks where the beak of this bug has been inserted. The false chinch-bug frequently occurs in such numbers as to attract general attention. The bugs crowd together on a plant in the same manner as do the chinch-bugs on corn, and the harlequin bugs on cabbage; and as they also feed by suction, they soon exhaust a plant by depriving it of its juices, which in time causes it to wilt and die. This is an active bug, and when alarmed on warm days, the winged individuals readily take to flight, arising in swarms. It is subject to the same atmospheric influences as the chinch-bug, and damp, rainy weather is unfavorable to its development. It has been surmised that there are two or three generations a year and that the insect hibernates mainly in the perfect state under rubbish of different sorts.[1]

REMEDIES.—The best way of controlling this bug consists in the keeping down of purslane, a favorite food plant, the careful cleaning up and burning of all trash before winter, the collection of the bugs when they occur in numbers in pans or pails filled with water and a thin scum of kerosene, and the free use of 10 per cent. kerosene emulsion.

The Cabbage Aphis (*Aphis brassicæ* Linn.).—In seasons when atmospheric conditions favor its development this insect, which is also known as the "cabbage louse",[2] can be exceedingly troublesome; indeed, were it not for its susceptibility to many natural enemies, it would always be a pest of the highest importance in localities adapted for its increase. This species affords a most excellent example of the usefulness of natural enemies. A vast number of insects that prey on aphides

[1] A related bug (*Nysius minutus* Uhl.) very nearly resembles the preceding in appearance and in habits, and may be controlled by the same methods.

[2] A similar aphis (*Rhopalosiphum dianthi* Schr.), with somewhat similar habits, is also very injurious to cole crops and may be controlled by about the same means.

attack it, and in many regions hold it down to moderate numbers save in exceptional seasons. In dry, warm weather the insect enemies are most active, while in cooler dry weather they are less efficient and then the plant-lice frequently gain the ascendency, to the detriment of the cabbage crop.

Its first appearance is usually noticed in June, and it remains

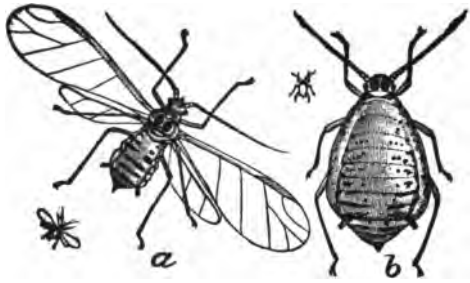

Fig 102.—Cabbage aphis. *a*, So-called "male"; *b*, wingless viviparous female. Greatly enlarged; natural size indicated by small outlines. (After Curtis)

until quite cold weather. In the District of Columbia the writer has observed this species active as late as the middle of December, mostly, however, at this time, in the hearts of cabbage, where the aphides had crawled for protection.

Practically the same or related insect enemies of the pea aphis which have been mentioned in preceding pages attack the cabbage aphis.

REMEDIES.—The cabbage aphis can be controlled by much the same remedies as advised for the melon aphis (page 165), the free use of pyrethrum applied by a bellows at any stage of the growth of the cabbage or other plant; or by kerosene emulsion, which is of value when the plants are young and until the heads begin to complete their growth. Soap solutions may be used if preferred, those known as whale-oil soap, made of fish oil, and potash soaps, made from caustic potash, being the best. A strong stream of water directed upon the plants from a

syringe, hose or spraying machine is often of service in checking the work of this insect. Application of remedies should be made upon the first appearance of the insects. Clean cultural practice should be observed.

MAGGOT LEAF-MINERS

The leaves of cabbage, turnip, radish and other crucifers are subject to the attack of minute maggots which manifest their presence by whitish blotches of larger or less extent,

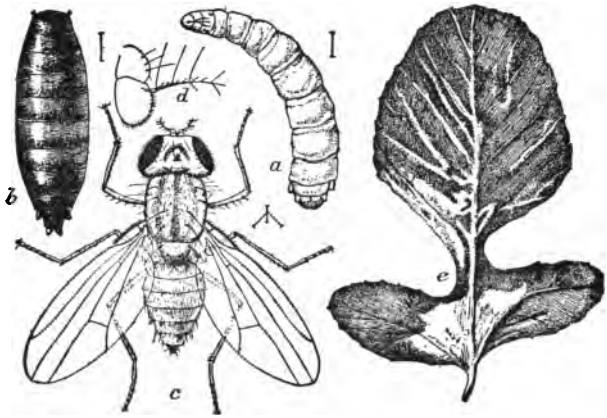

Fig. 103.—Imported turnip leaf-miner. *a*. Larva; *b*, puparium; *c*, adult; *d*, antenna of fly; *e*, work in radish leaf. Natural size; all others enlarged. (Reengraved after Coquillett, U. S. Dept. Agr.)

termed mines. If a leaf be held toward the light the maggot can be seen at work between the surfaces. Four species of leaf-miners commonly affect crucifers. These insects are not as a rule very destructive, but they kill off leaves here and there, thus weakening the plants, and rendering them more liable to disease and to injury by other insects. Sometimes, however, they destroy whole plants. Attack is more apparent on young plants and is easily recognized. One of the commonest

of these insects is the imported turnip leaf-miner *(Scaptomyza flaveola* Meig.) shown in figure 103.

REMEDIES.—These leaf-miners are not very injurious to large interests. In small gardens they can be controlled by clipping the infested leaves as soon as the mines appear and destroying them.

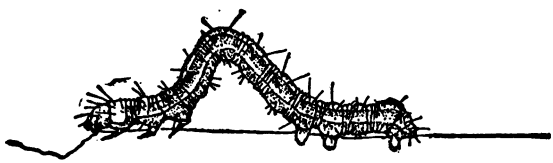

Fig. 103x.—A young cabbage looper, highly magnified. (Author, U. S. Dept. Agr.)

CHAPTER X

INSECTS INJURIOUS TO CUCUMBER, MELON AND RELATED PLANTS

If we except cabbage no vegetable crops suffer more from the ravages of insects than do the cucurbits—squashes, cucumbers and melons. They are subject to attack from the time the seed is planted and after it has sprouted until the fruit is ripe for market. Injury is not effected by so many species of insects, as in the case of cabbage, less than a score of distinct forms being commonly identified with damage, but of these nearly a dozen are highly injurious, and half as many from their extensive distribution and destructiveness are of the greatest importance. It is no uncommon sight to see four or five distinct species on a single plant, and several others in the same field.

The seeds are attacked in the ground by a maggot which eats into them and prevents germination. After the seed has sprouted the plant becomes the prey of the striped cucumber beetle, the most troublesome of all cucurbit-feeding insects. Such plants as are so fortunate as not to be attacked by this beetle, cutworms and some few other "general feeders" may next encounter the squash bug and then the squash-vine borer. The latter severs the vine or injures it so that it wilts and dies. It is next to impossible in many portions of the United States to find cucurbits that are wholly free from the melon aphis which feeds by absorbing vegetable juices by suction. After the plants have escaped the insects above enumerated

they are still liable to injury from others and more especially from the pickle worm and melon caterpillar which bore into the fruit and render it unfit for market.

Cucurbits grown under glass are subject to injury by four important pests: the striped cucumber beetle, melon aphis, greenhouse white fly and onion thrips.

The Striped Cucumber Beetle *(Diabrotica vittata* Fab.).— With the first appearance of cucumber, squash and melon plants

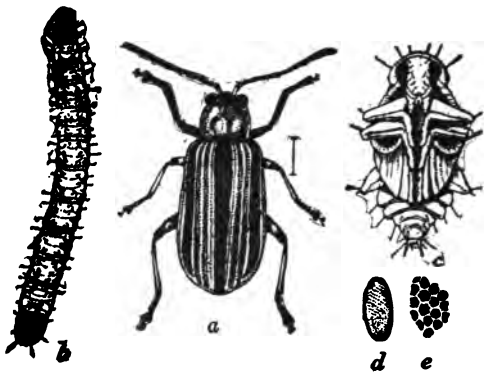

Fig. 104 —Striped cucumber beetle. *a*, Beetle; *b*, larva; *c*, pupa; *d*, egg; *e*, sculpture of egg. (Author's illustration, U. S. Dept. Agr.)

early in the season, often before they are above ground, they are attacked by the striped cucumber beetle, often called the "striped bug" and "melon bug."

The beetle measures about two-fifths of an inch in length. Its color is yellow above, with black head and elytra longitudinally striped, as figured (fig. 104). The egg is lemon yellow and of the appearance shown, where the sculpture is also illustrated. The larva is a slender, white, worm-like creature, with brown head, anal and thoracic plate. When mature it measures about three-tenths of an inch, this being about ten times its width. The species is indigenous and inhabits the entire eastern United States.

The principal injury is effected by the hibernated beetles devouring the tender plants before they have fairly started. The beetles are also destructive to older plants, by eating the leaves and gnawing the rind of stems and the fruit, while the larvæ cause injury through their pernicious work at the roots. Still another form of mischief is due to the beetles in acting as carriers of the insidious bacterial disease "cucurbit wilt."

The beetles usually make their appearance in April or May, feed on flowers or other vegetation, and when cucurbits are set out attack and injure them as previously described. Eggs are deposited soon after the host plants are well above ground, and on leaf-stalks just below the surface of the ground. The larval period is passed in the earth, about the bases of the stalks, and larvæ may be found within the stems under as well as above ground, and there is an active stage of about a month's duration in which the larvæ working in numbers have ample time for injuring the vines.

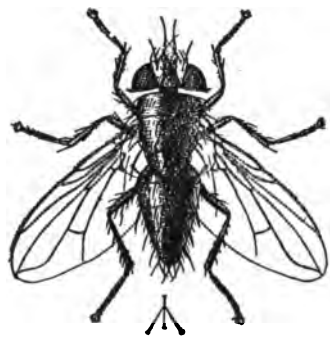

Fig. 105.—*Celatoria diabroticæ*. Fly parasite of cucumber beetles. Much enlarged. (Author's illustration, U. S. Dept. Agr.)

Toward the end of the season the beetles congregate under stems, prostrate plants and withered leaves of cucurbits, as many as sixty individuals assembling about a single plant, and later they seek other places of shelter. Hibernation near Washington evidently begins during the first cold nights of October.

Great numbers of this insect are destroyed by a dipterous parasite, somewhat resembling a small house fly, and known as *Celatoria diabroticæ* Shim. (fig. 105), which develops as a maggot within the beetle, which it destroys when it issues.

REMEDIES

How to control this cucumber beetle is one of the hardest propositions to solve. Poisons will destroy the beetles when they occur in moderate numbers, but are not entirely efficacious when they are most abundant, hence recourse must be had to preventives and repellents, and to farm practice.

Coverings.—To prevent injury to young plants coverings are used. A cheap frame may be made by cutting a barrel hoop in two so as to form two semicircles, which are placed at right angles to each other, and the lower ends inserted in the ground with the curve uppermost. This is then covered with gauze or similar material, held in place so to prevent the beetles working through or under it.

Early planting, etc.—Where no covering is used it is advisable to start plants under glass, or to plant the earliest varieties and set them out as soon as possible so as to have the plant well established before the appearance of the beetles. The setting out of late varieties should be postponed until after the first appearing beetles have laid their eggs and dispersed. A certain degree of relief follows the planting of an excess of seed so as to distribute attack. After the first danger is passed the hills are thinned out to the desired number.

Clean farming and trap plants.—Much injury from this and other cucurbit pests would be prevented by more attention to clean methods of cultivation. As soon as a crop is harvested the vines should be covered with straw or other inflammable material and burned, and certain plants should be left here and there throughout the fields, so that such insects as may not be reached by the fire will concentrate on them where they can be destroyed with strong kerosene emulsion or Paris green. As traps for the last generation it would be wise to plant late or to use later varieties. Some exemption may be attained by growing beans with cucumbers in alternate rows. The beans are planted before the cucumbers and the beetles congregate

on the beans and, having an abundance of food, do not attack the young cucurbits.

Driving, etc.—In some sections "driving" is practiced. Air-slaked lime is dusted over the plants with the wind and the beetles fly before it to the next patch where similar methods have to be employed. Another remedy is to dust the majority of plants with sifted ashes, road dust or plaster, and cover those which are undusted with an arsenical, in the proportion of one-fourth of a pound to about 40 gallons of water. The beetles are thus driven to concentrate on the clean plants, where they are killed by the poison.

Refuse tobacco dust sprinkled on the hills when the soil is moist acts as a repellent and as a fertilizer and mulch for the plant. Applications must be renewed when rainfall necessitates.

Pyrethrum and other insecticides dusted on the plants are useful, but expensive. Paris green and other arsenicals applied dry as for potato beetles are valuable, but all poisons must be renewed frequently and are not generally to be relied upon when the beetles are exceedingly numerous. In case Bordeaux mixture is used as a protection against fungous diseases, Paris green should be added, as it necessitates little additional trouble and the mixture will prove more effective than either when used alone.

Stimulating growth.—A considerable degree of exemption from injury accrues from the stimulation of a crop by heavy manuring, or the use of mineral fertilizers and frequent cultivation.

The Twelve-spotted Cucumber Beetle (*Diabrotica 12-punctata* Ol.).—This beetle will be considered at length in the discussion of insects affecting sweet corn. In exceptional seasons it does nearly as much injury locally to cucurbits as the striped cucumber beetle, with which it is nearly always associated. At such times, the same remedies should be employed.

The Squash Ladybird *(Epilachna borealis* Fab.).—The leaves of squash, pumpkin and the other cucurbits are often found showing numerous wilted and eroded circular or semi-circular spaces. The source is not far to seek, and can readily be traced to the squash ladybird and its larva. This insect is of the characteristic hemispherical ladybird form. It is ochraceous in color, marked with rounded black spots, as shown in figure 106, *c*. This is one of our largest ladybirds, measuring about one-third of an inch. The larva is yellow and covered

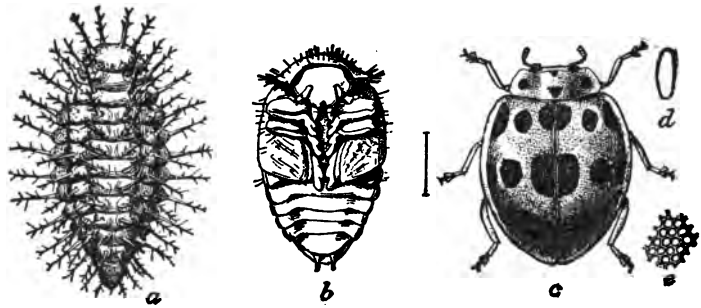

Fig. 106.—Squash ladybird. *a*, Larva; *b*, pupa; *c*, beetle; *d*, egg; *e*, surface of same. *a*, *b*, *c*, Three times natural size; *d*, four times; *e*, highly magnified. (Author's illustration, U. S. Dept. Agr.)

with spines arranged in six rows except on the first thoracic segment, where there are four *(a)*.

This is an indigene, ranging from South America to Maine and Canada. It is essentially an eastern form, occurring abundantly along the Atlantic seaboard.

The singular habit of the larva and beetle of feeding within a circumscribed space, as previously noted, is evidently characteristic of this genus of ladybirds. It first marks out a circle, or if it is feeding on the edge of a leaf a more or less complete semicircle, thus enclosing a portion within which it feeds. The larva lives on the lower and the beetles on the upper surface, but the latter may often be found on the under

side, and devour all parts except the veins and late in the season sometimes eat the rind of the fruit. The beetle hibernates under convenient shelter and appears abroad in May or June according to season and locality. A single generation has been observed.

REMEDIES.—Remedial measures adopted for other cucurbit pests will effect the destruction of this ladybird. Its habit of feeding exposed on the leaves renders it vulnerable to poisonous applications, and of these the arsenites, dry or in solution, are best. Hand-picking the beetles and egg masses is the only measure necessary under usual circumstances.

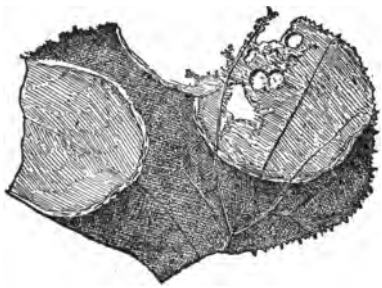

Fig. 107.—Work of squash ladybird on a squash leaf. Natural size (Author's illustration, U. S. Dept. Agr.)

The Squash Bug (*Anasa tristis* DeG.).—Of all insects which infest squash and pumpkin the squash bug is the best known. It is also called "stink-bug" from its disagreeable odor, and black or gray squash bug to distinguish it from the so-called "striped bug." In some seasons as, for example, in 1901 and 1902, it even vies with the latter in point of destructiveness.

The adult bug, shown twice natural size in figure 108, *a*, is nearly three-fourths of an inch long, dirty blackish brown above and mottled yellowish beneath. It is more or less harmful during its entire active existence, from the time it leaves the egg till its demise. When numbers attack a plant together it

is soon exhausted, the tips and leaves wilt and its death follows. It is not alone the extraction of the juices that destroys a plant; whenever the bug "stings" a leaf-stalk, it injects a liquid, which has a poisonous effect, causing the death of the cell tissue about the puncture. It attacks also the leaves and occasionally the fruit, and acts as a transmitter of the "wilt."

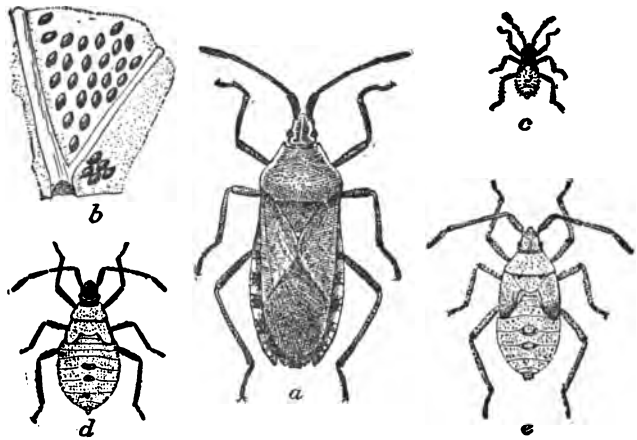

Fig. 108.—Squash bug. *a*, Adult; *b*, egg mass; *c*, *d*, *e*, nymphal stages. Enlarged (Author's illustration, U. S. Dept. Agr.)

On young plants a few punctures are sometimes sufficient to cause death.

The common squash bug is known throughout practically the entire United States, being particularly abundant east of the Rocky Mountains, where it ranges from Maine to the Gulf States and westward to California.

Injury may begin soon after the sprouting of the plants, or after they have made considerable growth, and may continue until their death or the departure of the bugs for hibernation. Plants are first attacked by the hibernated bugs. Soon after their appearance, which varies according to temperature and locality from early spring in the South to late in June farther

north, the insects deposit their eggs, attaching them by an adhesive secretion to the leaves in masses of three or four to forty or more. The eggs are metallic brown or bronze and flattened on three sides. They are laid usually on the under side of a leaf, but not infrequently on the upper side, in more or less regular rows (fig. 108, *b*). They hatch in from eight to thirteen days into small, green and black creatures, which resemble somewhat the mature insects, having proportionately longer legs and antennæ. In this period of its existence, the first nymph stage (fig. 108, *c*), the insect lives in colonies, at

Fig. 109.—*Trichopoda pennipes*. Tachina fly parasite. Three times natural size (Author's illustration, U. S. Dept. Agr.)

first remaining close together upon the leaf near where the eggs were laid, but later congregating about the bases of leaf-stalks or hiding, together with individuals of the more advanced stages, under clods or rubbish or in any convenient retreat, and coming forth toward dusk in search of food. The nymphs cast their skins five times before reaching the mature condition, increasing their growth with each molt. In its last stage the squash bug continues to feed, but with the disappearance of its food supply, caused by the dying or clearing away of the crop on which it has fed, it seeks shelter in any convenient rubbish, under boards or stones, dead vegetation, or under

bark, or in cracks of barns, and here passes the winter. Hibernation in the District of Columbia begins sometime in September.

This bug is often parasitized by a tachina fly which assists in holding down its numbers. It is *Trichopoda pennipes,* shown in figure 109.

METHODS OF CONTROL.—This insect is unusually resistant to insecticides. A wash strong enough to kill the mature insect will destroy the vines. This renders it necessary to proceed by hand and cultural methods.

A lookout for the bugs should be kept early in the season and these as well as the eggs should be picked off or cut away and destroyed. The eggs are readily seen, and the grower should make a practice at the beginning of each season of going over the vines every few days. Such young as hatch in spite of these precautions may be killed by kerosene emulsion if applied at their first appearance.

The bugs may be trapped by placing about the garden boards, shingles, or similar material, which will attract them for shelter. Here they should be destroyed every morning or so during the early season. Protection to cucurbits other than squash, and perhaps pumpkin, can be facilitated by growing these plants with others to serve as trap crops. Attack will thus be centered on a few plants where the insects can be the more readily controlled.

A number of the remedies in use against the striped cucumber beetle and other insect enemies of cucurbits will assist in the control of this species. Among these are the protection of young plants with coverings, the use of repellents, planting an excess of seed to distribute attack, stimulating the plant by manures or other proper fertilizer, and lastly, clean cultural practice. If the vines as soon as the crop is harvested are gathered and burned, many bugs will be destroyed and the number reduced for the ensuing year.

The Melon Aphis *(Aphis gossypii* Glov.).—The melon aphis or "louse" may serve as typical of the plant-lice. It is in some seasons one of the most important enemies of melons and some other crops, and is injurious like other aphides by piercing the plants affected with its beak and thus sapping their vitality. It occurs from early spring to late in autumn on cucurbits of all kinds, many other crops and weeds of great variety and in its seasons of abundance, notably following springs that are cool and rainy, it frequently does very serious damage, causing the leaves attacked to curl, shrivel and lose color, interfering with the ultimate development of the fruit, if not killing the plants outright.

The melon aphis is variable dark green in color and of sluggish habit.[1] The principal stages are illustrated in figure 47. Winter eggs have been found on strawberry and purslane. This species is of unknown but perhaps tropical origin, since it shows a decided preference for, and has done most injury to, plants of a tropical nature, such as cucurbits, cotton and orange.

METHODS OF CONTROL

The severe losses occasioned by this insect in seasons when it multiplies in unusual numbers could be largely mitigated and, in small areas, almost entirely prevented if the employment of methods of destruction were begun upon its first appearance. First of all, it is necessary to familiarize oneself with the insect and the condition of the plants by which its presence is manifest that measures of control may be instituted before it is too late. In ordinary seasons it is controlled by natural elements and insect enemies alone, and when the weather is unfavorable to the development of the latter the grower should be on the alert.

[1] The only other cucurbit louse with which it is apt to be confused is the squash aphis (*Nectarophora cucurbitæ* Middleton), a much larger species and more uniformly paler green in color.

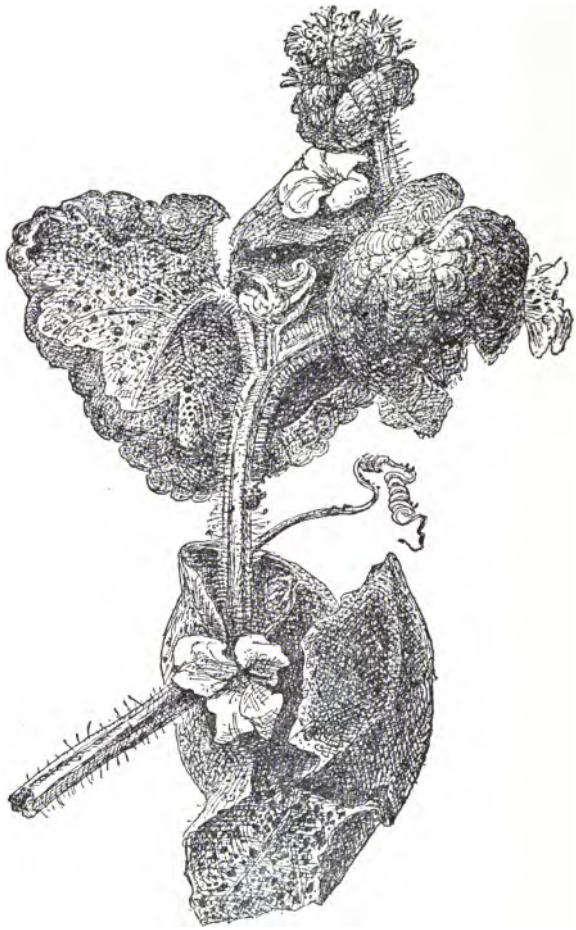

Fig. 110.—Cantaloupe leaves showing curling caused by melon aphis: aphides on lower surface. Slightly reduced. (Author's illustration, U. S. Dept. Agr.)

Bisulphid of carbon.—In small fields it is customary to cover hills of melons as soon as the insects make their appearance with a tub or similar receptacle, and evaporate beneath this bisulphid of carbon at the rate of a drachm to a cubic foot or less of space. A tablespoonful serves for ordinary tubs. This does not injure the plant, and if the tub fits tightly to the ground so as to retain the vapor of the bisulphid, the "lice" will all be killed. Large growers watch vines carefully, removing and destroying affected plants as soon as noticed to prevent spreading the trouble.

Kerosene emulsion and soap solutions.—The melon aphis could be more readily dealt with if it did not feed on the under surface of leaves, and if vines like melons did not grow so closely together as to interlace that spraying by ordinary means is practically impossible. Under-spraying is a necessity, and the sprayer used should be fitted with an upturned nozzle to secure this effect.

Soap solutions, such as whale-oil, fish-oil and potash soap, are not so useful.

Clean farming with fall plowing should always be followed, as it is a most valuable measure of prevention of attack by aphides and other insects that are present. As soon as the crop is off remnants should be gathered and burned, and all weeds kept down until the fields are again planted, since, as has been shown, common weeds of the field and garden serve as alternate food plants, and are selected as hibernating quarters by the "lice."

Pyrethrum applied to the underside of the leaves with a powder bellows is effective, but can not be used with profit on large fields or on plants like squash with large leaves.

Remedies that have been indicated as of service in the control of the melon aphis operate against many other insects which are usually present at the same time. Thus the kerosene and soap solutions kill small squash bugs and act as

deterrents of other insects, bisulphid of carbon destroys other aphides and small bugs, as does also pyrethrum.[1]

The Squash-vine Borer (*Melittia satyriniformis* Hbn.).—A most troublesome enemy of squash, pumpkin and other cucurbits is the squash-vine borer. In many localities it surpasses all other squash insects in point of injuriousness. Damage is due to the white grub-like larvæ boring through the stems, causing them to rot at the affected points and become severed from the vine. The presence of the borer in the stem is not apparent at the commencement of the attack, but soon becomes manifest through the presence of the yellowish powdery excre-

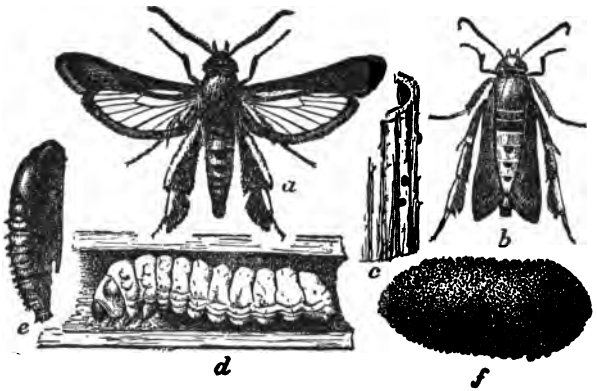

Fig. 111.—Squash-vine borer. *a*, Male moth; *b*, female, with wings folded in natural position when at rest; *c*, eggs shown on bit of squash stem; *d*, full-grown larva, *in situ* in vine; *e*, pupa; *f*, pupal cell. All one-third larger than natural size. (Author's illustration, U. S. Dept. Agr.)

ment which it forces from its burrow in the stem and which accumulates on the ground beneath, as well as by the sudden wilting and dying down of the leaves. From one to upwards of 145 individuals have been reported taken from a single plant. The larvæ work with great rapidity and in a short time in-

[1] A detailed account of the melon aphis, Circ. 80, Bu. Entom., U. S. Dept. Agr., should be consulted for a full consideration of remedies.

jure a plant so that no fruit will mature. Injury is most noticeable near the bases of the stems, where in course of time the vine becomes severed from the roots.

The parent insect (fig. 111, *a*) is a beautiful clear-winged moth. The fore-wings are lustrous olive-brown, with metallic green reflections, and expand about an inch and a fourth. The

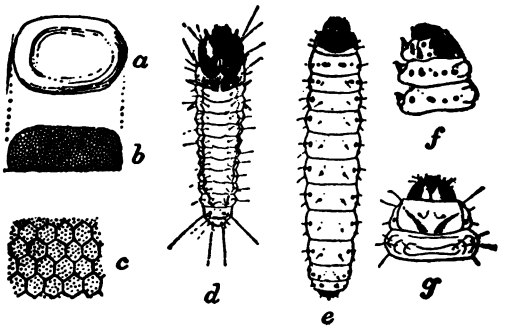

Fig. 112.—Squash-vine borer. *a*, Egg seen from above; *b*, same from the side showing sculpture; *c*, sculpture of egg greatly enlarged; *d*, newly-hatched larva; *e*, half-grown larva; *f*, head of same from side; *g*, head of mature larva from above. *a*, *b* and *d*, Much enlarged; *e*, *f* and *g*, less enlarged. (Author's illustration, U. S. Dept. Agr.)

abdomen is marked with orange or red, black and bronze, and the hind-legs are fringed with long hairs.

The larva is soft, whitish and grub-like. Mature larvæ measure about an inch. In the District of Columbia full-grown larvæ occur as early as the middle of July and as late as the second week of November. After attaining maturity the larvæ enter the earth to the depth of one or two inches and form cocoons (fig. 111, *f*) constructed of silk and coated externally with fine particles of earth. Observations indicate that this species is practically single-brooded northward; that there is a tendency to two broods in New Jersey; that in the District of Columbia the species is partially double-brooded, and that in the Gulf States it is fully two-brooded.

PREVENTIVE AND REMEDIAL MEASURES

This borer is exceptionally difficult of control, as ordinary insecticides are of no value after the insect has entered the vines, and repellents are also practically useless. We are, therefore, dependent upon cultural methods for relief. Knowing that the insect passes the winter in the fields which it has ravaged, it should be superfluous to caution growers not to plant squashes in the same ground in successive years.

Early squashes as traps.—Good results are obtained by planting as early as possible a few summer squashes, such as crookneck and early cymblin, before, and between rows of, the main crop of late varieties. The summer squashes attract the insects in numbers, leaving a smaller number to deal with on the main crop. As soon as the early crop is gathered, or earlier if the ground is needed for the main crop, the vines are raked up and burned to destroy all eggs and larvæ which they may harbor, and the same treatment is followed after gathering the late varieties.

Fall harrowing and spring plowing.—This species can be greatly reduced by lightly harrowing the surface of infested squash fields in the fall so as to bring the cocoons to the surface, where they will be exposed to the elements, and then plowing in the spring to a uniform depth of at least six inches so that the adults will not be able to issue.

Cutting out the borers, although laborious, is about the only method open for employment after they have entered the vines. It is best to cut longitudinally, so as not to sever the vine from the root stalk. The location of the borer in the vine can be detected by the accumulation of its yellow excrement at the point where it is working.

Other methods.—When vines have attained some length parts of them should be covered with earth so that secondary roots will be sent out in case the main root is injured. Keeping plants

in good condition, free from disease and other insects, and well nourished, with the assistance of manure or other fertilizer if necessary, will also aid them to withstand attack. If the grower would make certain of securing a good crop in localities where this and other enemies of the squash occur in their most destructive abundance, it will be necessary for protection against this borer to observe most of the precautions specified and, if possible, secure the cooperation of his neighbors.

The Pickle Worm *(Diaphania nitidalis* Cram.).—In the Gulf States and occasionally farther northward two caterpillars are quite injurious to the fruit of melons and other cucurbits. The term "melon worm" is applied to both, as also to the squash borer, since all have the habit of boring into melons; the last-mentioned, however, is a vine-borer, while the other two, known respectively as the pickle worm and melon caterpillar, feed in their earlier stages in the buds or leaves, and in their later stages in the fruits, which they frequently destroy. They are about equally destructive and work usually by boring directly into the interior, but sometimes eat cavities in the rind.

Injury by the pickle worm is seldom noticed until it enters the fruit.

The moth (fig. 113, *e*) is a beautiful creature, quite distinct from any other common species. The upper surface is brown with purplish iridescence. Near the middle of the fore-wings is a somewhat irregular yellowish semitransparent spot, and the inner half or a little more of the lower wings is of the same color. The wing expanse varies from an inch to nearly one and a half inches. Larvæ (*a, b, c*) vary from yellowish to dull brownish green, with a dorsal row of shining round spaces of the same color.

The pickle worm is indigenous to America and is probably of tropical origin. It occurs from South America to New York, Michigan and Illinois. It is injurious every year in the Gulf States, instances of damage farther north being only periodical.

Injury appears to be practically due to the later-appearing generations, and more especially to muskmelons raised for northern markets. In September, 1897, fields of cymblins cultivated in Maryland, Virginia and the District of Columbia were badly damaged or totally destroyed by the pickle worm, but in the after years the insect has almost entirely disappeared.

The life history and habits of this species have been studied

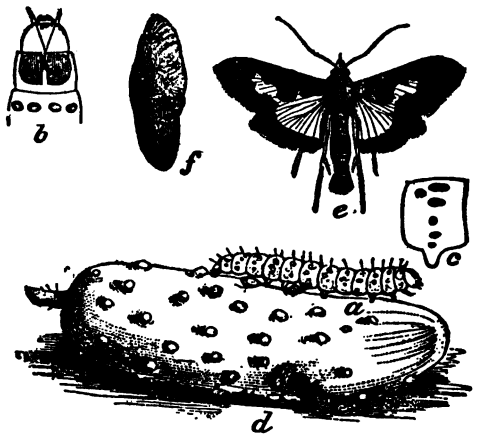

Fig. 113.—Pickle worm. *a*, Larva; *b*, head and first three segments of larva; *c*, segment from side; *d*, pickle showing injury; *e*, moth; *f*, cocoon. *a*, *d*, *e*, *f*, Slightly enlarged; *b*, *c*, more enlarged. (After Riley.)

by Prof. A. L. Quaintance, in Georgia. Larvæ are first noticed there about the middle of June. Eggs are deposited on the flowers, buds, or tender portions of a plant. The larvæ first eat out cavities in the leaves or stems, the angle between a leaf and stem being a favorite place of entrance. Frequently they enter flower buds, and have been found by the writer destroying many prospective cymblins in this manner. With the second stage, at least southward, the larvæ feed on the young fruit, and as they mature they pass from plant to plant and thus injure for sale much of the fruit affected. They void large

quantities of soft excrement and when several larvæ have bored into a fruit it becomes a most disgusting object, quite different from the beautiful moths as they flit about the garden. The length of the life cycle in the South in midsummer is between 24 and 27 days and three generations seem to have been definitely recognized there. When the larvæ have finished feeding they crawl out from the infested fruit and transform to pupæ within the fold of a leaf or under any sort of debris on the ground.

METHODS OF CONTROL.—The methods that have been advised as most valuable against the striped cucumber beetle and other species, more particularly clean farming, fall plowing and rotation of crops, are useful, but the pickle worm has never been successfully combated. The writer suggests the combined use of arsenate of lead and Paris green, spraying with the former, at the rate of one pound to from 15 to 25 gallons of water, beginning at about the time that the buds commence to form, and making a second application a week or two later, according to how well the arsenate remains on the foliage. A third spraying may be made if necessary, following with a final spray of Paris green (1 pound to 130 gallons water) within about a week of the time of the ripening of the fruit. As the arsenate is very adhesive, its use is not advised for the final spraying. The Paris green which is substituted at this stage is perfectly harmless, as it readily washes off if, indeed, any will remain by the time the fruit is placed on sale. This treatment is designed to kill the "worms" before they enter the fruit, since they cannot be reached after they have obtained entrance. The "worms" are poisoned while feeding on the buds, leaves and other parts, as well as on the rind of the fruit.

The Melon Caterpillar *(Diaphania hyalinata* Linn.).—This species and the preceding resemble each other in many particulars and are especially alike in their larval stages, but there

is this difference important to the grower, that the first generation of the melon caterpillar usually attacks the foliage, particularly of muskmelon, to which it, as well as the preceding, is most destructive. By reason of this habit we can control it, in

Fig. [illegible].—Melon caterpillar: [illegible] Natural size [illegible]

a measure at least, with arsenical poisons, which is impossible with the pickle worm, since the latter lives internally throughout its later larval stages.

The parent moth has the wings [illegible] with a strong [illegible] and [illegible] (fig. [illegible]). The caterpillar when full grown is a little smaller than the pickle worm, measuring about [illegible] of an inch. It is pale greenish yellow, with [illegible] markings. It is southern in distribution.

occurring abundantly in the Gulf States. The "worms" of these two species are frequently confounded because of their similar appearance. Both feed in the same fields and their life habits exhibit little variation.

REMEDIES mentioned for the pickle worm are applicable, as the melon caterpillar can be killed readily by an arsenical spray.

Miscellaneous Pests.—The onion thrips, considered on pages 89 and 90, the wheat thrips (page 90) and the red spider (page 91) are all important enemies of cucumbers grown under glass, as is also the greenhouse white fly (*Aleyrodes vaporariorum* Westw., fig. 114*x*). Indeed in the case of the last mentioned pest it would be impossible to grow this crop in forcing houses without the employment of remedial measures.

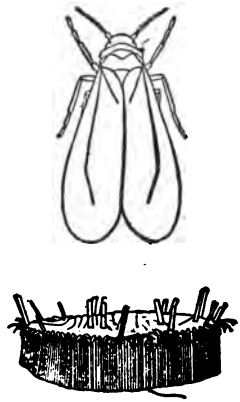

Fig. 114*x*.—Greenhouse white fly. Adult above, pupa below—highly magnified. (After Morrill.)

This pest can be held in control by vaporization or fumigation with tobacco or nicotine extracts, or by spraying with kerosene emulsion or the so-called whale-oil (fish-oil) soap. Care is necessary in using the extracts that the smudge does not become too dense and injure the plants. Before applying this remedy on a large scale a preliminary trial should be made following the directions on the packages, and reducing the amount if any ill results follow. Hydrocyanic acid gas properly used is an excellent remedy.[1]

[1] See Circ. 57, Bu. Entom., U. S. Dept. Agr., and Fumigation Methods, by Prof. W. G. Johnson, published by Orange Judd Company, New York.

CHAPTER XI

INSECTS INJURIOUS TO CELERY, PARSNIPS AND RELATED PLANTS

A CONSIDERABLE number of insects attack celery, but few are restricted to it as a food, and fewer yet do noticeable damage. A large proportion of the insects which live on it also attack carrot, parsnip, and parsley, preferring one or the other of these three plants. For convenience, however, we may consider the insect enemies of celery separately.

INSECTS INJURIOUS TO CELERY

What is true in this country is equally true in Europe, and there is little danger of the introduction of important pests from abroad. With the increased cultivation of this crop insects which now attack it may increase in injuriousness, but there is no immediate prospect of serious losses accruing from insect attack. It is seldom that beds of celery are entirely free from the celery caterpillar; the same may be said of the zebra caterpillar. The tarnished plant-bug is one of the worst enemies with which the celery grower has to contend, but its having many host plants usually distributes attack except in unusual seasons. Celery generally escapes the ravages of cutworms owing to its late planting and still later replanting, and neither white grubs nor wireworms deter its growth as far as observations go, presumably because of its powerful root and root stalk. The leaves are attacked by leaf-rollers and leaf-tyers and one of these, the celery leaf-tyer, is of considerable importance.

The Carrot Rust Fly (*Psila rosæ* Fab.).—This pest has been injurious to carrots in Canada since 1885 and made its ap-

pearance in 1901 in New York in celery fields. In attack on celery the leaves of young plants early in spring turn reddish, and the roots are blotched with rusty patches, particularly toward their tips. Roots of carrot when stored for winter, although not manifesting any degree of injury on the outer surface, are at times perforated in all directions by dirty brown-

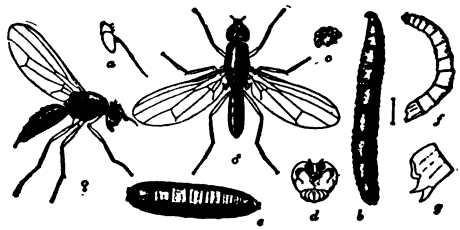

Fig. 115.—Carrot rust fly. ♂. Male fly; ♀, female fly; *a*, antenna of male; *b*, full-grown larva, lateral view; *c*, spiracles of same; *d*, anal extremity; *e*, puparium; *f*, young larva; *g*, anal segment from side. Flies, young and mature larva, and puparium, eight times natural size; other portions more enlarged. (Author's illustration, U. S. Dept. Agr.)

ish burrows, from which these whitish yellow maggots may be found projecting. When celery is infested the larvæ seem to begin eating into the thick part of the root when the plant is about half grown, stunting it so as to make it worthless for market.

This species is quite minute, the parent fly measuring only about one-sixth of an inch in length, with a wing expanse of a little more than three-tenths of an inch. The body is dark green and is rather sparsely clothed with yellow hairs. The head and legs are pale yellow, and the eyes black. The two sexes are shown at ♂ and ♀, figure 115. According to Curtis, when the imago issues from the puparium an oval lid on this portion lifts up, permitting the fly to crawl out. The posterior extremity ends in two minute dark tubercles.

The carrot rust fly is a pest in Europe, whence it has been introduced in this country. It is a northern species and is

permanently established in New Brunswick, Ontario and Quebec, Canada, besides occuring in New York and New Hampshire.

The life history of the carrot fly has not been entirely worked out. In the United States it will probably be found to pass the winter usually as a puparium, but as larvæ work also on carrots in store, the flies develop in winter, hence we have great irregularity in development, making generalization impossible until observations are made in the field.

The insect develops rather early in the season and both flies and maggots are found throughout the warmer months, but the latter desert the roots for pupation in the earth, the last generation probably descending much deeper than the earlier ones. Curtis states that the summer generations develop in three or four weeks. There are at least two, and probably more, generations annually. Miss Ormerod has observed that the female fly goes down into the ground where she can find a crack or other opening about the roots of the plant affected. Here she lays her eggs, and the maggots, when hatched, work their way into the root; when this is quite small they often destroy the lower portion.

METHODS OF CONTROL

The carrot rust fly is difficult to reach with insecticides. Our principal dependence is based upon methods of tillage which will avert attack.

Kerosene emulsion in the proportion of one part to ten of water sprayed upon the carrots along the rows, or sand, or ashes, with which kerosene is mixed at the rate of half a pint to three gallons, sprinkled along the rows, have given good results. These substances deter the fly from laying her eggs.

Late sowing and rotation of crops are excellent remedies, as is also the planting of new beds as far as possible from land infested the previous season.

Destruction of stored carrots.—Where carrots are stored for winter use in earth they should be treated to destroy the larvæ or puparia. This may be accomplished by burying the earth deeply; by spreading it in thin layers where it will be exposed to the elements; by throwing it into pools where it will be frozen; or by exposing it to heat or steam in any convenient manner.

Treatment of celery beds.—As this insect also infests celery, that crop should not follow carrots (nor carrots celery) in rotation. Clean farming should be practiced, which includes the destruction of remnants after the crop has been harvested.

After harvest, it would be a good plan to give celery fields a raking or cultivating of sufficient depth to expose the larvæ or puparia to frost; early the following spring, before the flies issue, if the earth be plowed deeply, it will have the effect of destroying such insects as have not been killed by frost and survive cultivating and raking.

The Celery Caterpillar *(Papilio polyxenes* Fab.).—Because of its large size and brilliant colors, both as larva and adult, this is one of the best known of the enemies of celery and allied plants. The caterpillar is green, or yellowish, and ringed with black and spotted with yellow. It attains a length of two inches. The parent insect is known as the black swallow-tail. It is velvet black, relieved by yellow bands in the male. The hind-wings are ornamented on the interior margin by eye-like markings like those of the peacock and the wings terminate in the tails from which it derives its common name. The female is somewhat faded black and of more sombre appearance than her mate. The wing expanse is about three inches. The chrysalis is dull gray, mottled with dull brown. It measures a little less than one and one-fourth inches. The celery caterpillar is one of the most interesting insects that attack garden plants. It appears to be limited to no special life zone, occurring throughout Canada and every State and Territory in the

Union, southward through Central America and the West Indies to Venezuela. The young larvæ are utterly dissimilar to the mature ones, and five distinct stages have been noted.

This insect affects practically all umbelliferous crops, celery, carrot, parsley, caraway, fennel, parsnip, dill, and related wild plants. It does not appear to attack, except in extreme cases, any plant outside of this botanical family.

REMEDIES.—The conspicuous coloration of the celery caterpillars renders them an "easy mark" as they are readily found and can be crushed under foot, and no other remedies are necessary if the work of destruction is begun before the plants are injured. The killing off of the first generation will serve in considerable measure to destroy the insects for the second brood, if this work be done over a considerable area. The butterfly, however, is strong of flight, and cooperation must be had to keep the insect in check when it becomes destructive.

The Celery Leaf-tyer (*Phlyctænia ferrugalis* Hbn.)[1].—This little insect, known also as the greenhouse leaf-tyer, first came to notice as a pest in 1888. On celery it feeds by preference on terminal leaves, and sometimes burrows into the stems. On one occasion in the District of Columbia it was so destructive that one grower had determined to abandon celery culture on this account. Next year, however, the insect was less troublesome; and this was fortunate, for if it were not periodical it might be a very bad pest indeed. In the field this leaf-tyer attacks besides celery cabbage, beets, tobacco, lettuce, cauliflower, parsley, cucumber, sweet pea and strawberry. It causes great injury to many greenhouse plants—violet, rose, chrysanthemum, carnation, ivy, heliotrope, and others.

The moth is a pale reddish-brown, expanding about three-fourths of an inch. The fore-wings are pale clay brown, suffused with reddish or ochreous brown, ornamented with black lines (fig. 116, *a*, *b*). The hind-wings are gray, with darker margins.

[1] For a detailed account see Bul. 27, Bu. Entom., U. S. Dept. Agr.

This moth resembles that of the garden webworm (page 61). The larva is green or greenish yellow, somewhat translucent, with whitish head, marked with purplish dots (fig. 116, *e, d, f*).

This is an introduced species, and obviously of tropical origin. Owing to its adaptability to indoor habits it is likely to be found anywhere.

The leaf-tyers work usually on the under surfaces of leaves, or on such as are shaded by other leaves. When young they eat out small holes on the under surfaces, leaving the upper

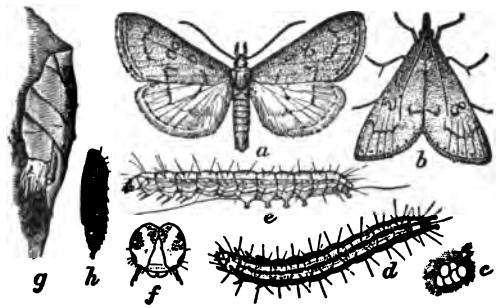

Fig. 116.—Celery leaf-tyer. *a*, Moth; *b*, same in natural position at rest; *c*, egg mass; *d*, larva from above; *e*, same from side; *f*, head of same; *g*, pupa case; *h*, chrysalis. *a, b, d, e, g, h*, One-half larger than natural size; *c*, twice natural size; *f*, more enlarged (original).

epidermis untouched; but as they increase in growth the leaves are skeletonized and sometimes entirely devoured. Larvæ work chiefly at night and rest by day in the same locations. They prepare for transformation to pupæ by spinning up between two leaves, or by rolling up a case at the edge of a leaf. (See fig. 116, *g*). Owing to the somewhat secluded manner of life of the larva, attack is not noticeable until considerable injury is done; but its presence can be readily ascertained by striking the plants lightly, when the moths start up, fly a short distance, then alight, and disappear under a leaf. In midsummer the entire life cycle, according to the writer's observa-

tions, may be passed in five weeks, but the outdoor spring and fall generations require a longer period. There are at least two, and frequently three, generations produced in the open; and in a warm equable indoor temperature there is a possibility of four and perhaps five.

REMEDIES.—In greenhouses this leaf-tyer is controlled by trimming away and destroying infested leaves as often as they are detected. The moths are killed in great numbers by placing lights over vessels of water on which a thin scum of kerosene floats. These remedies are less valuable in the field, but Paris green and other arsenical sprays, if applied at the outset of

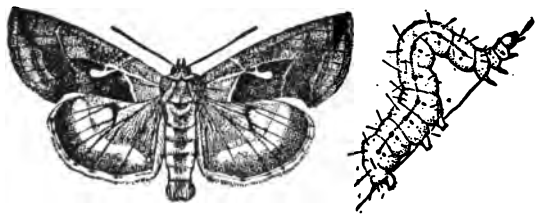

Fig. 117.—Celery looper. Male moth at left, larva at right. Somewhat enlarged (Author's illustration, U. S. Dept. Agr.)

attack, will destroy the larvæ, though less effective after they have become concealed in their tied-up leaves and in the growth of leaves about them. Spraying should be thorough, and an underspray is desirable.

The Celery Looper *(Plusia simplex* Guen.).—This species is the commonest of its kind in Illinois, and is rather generally distributed in the United States east of the Rocky Mountains, from Canada to New Mexico. It is described by Messrs. Forbes & Hart as a very destructive celery insect, and occurs also on sugar beet and lettuce.

The moth (fig. 117) has a greater wing expanse than the cabbage looper, measuring nearly two inches, has different coloration, and differently shaped upper-wings. The border of the fore-wings is not scalloped, the color is somewhat purplish

brown, the darker shades velvety brown. The larva is similar to the cabbage looper and similar remedies are applicable.

The Little Negro Bug (*Corimelæna pulicaria* Germ.).—This minute black bug sometimes does considerable damage to celery, as happened in 1893, when attack was quite general throughout the celery-growing portions of Michigan. The insects collect in clusters around the nodes where the three top leaflets meet. Here they suck the sap until the leaflets wilt and droop, after which they go to the joint below and repeat the operation till the leaf is drained of sap.

The mature negro bug measures only about an eighth of an inch, and is glossy black, the scutellum occupying over half of the upper surface and being surrounded by a white margin. This insect is common and well distributed. It prefers old celery when about ready for blanching and plants are retarded in growth from two to three weeks, recovering with large numbers of small curling, gnarly stalks of little or no market value. In such cases the crop is practically an entire loss. This species is a general feeder attacking numerous garden plants, among which are strawberry and blackberry, and it is due in part to this insect that these berries sometimes have such a disgustingly sour taste, and "buggy" odor, particularly when picked in the field.

Remedies.—Carbolic or kerosene emulsion are useful both as destroyers and repellents. In experiments conducted by Mr. G. C. Davis, the bugs were readily killed with hot water at a temperature of 155° F., and the celery plants were found to endure a stream heated to 175°. This remedy is most effective when the insects first appear and when applied on the plants where they are most numerous. It necessitates the use of a thermometer that the temperature may not go above 175°. Celery should not be planted in the vicinity of weedy fields, especially those containing umbellifers, as these harbor the insects sometimes in enormous numbers.

INSECTS INJURIOUS TO CARROTS, PARSNIPS AND PARSLEY

In this category we include parsley although it does not seem to have any insect enemies of its own. These plants belong to the same family (Umbelliferæ) as celery, and as stated in a preceding page most of the insects enumerated as affecting that plant are liable to attack these also, but both parsnip and carrot have particular species that infest them,

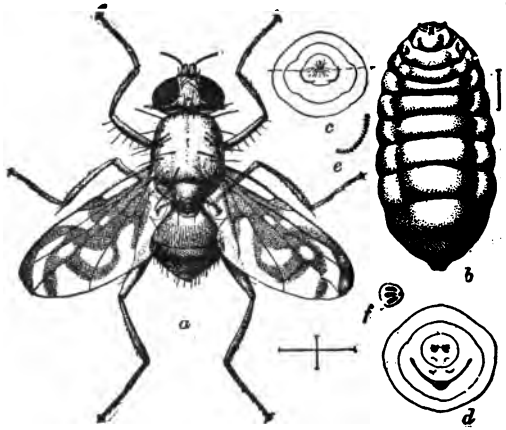

Fig. 118.—Parsnip leaf-miner. *a*, Fly; *b*, larva; *c*, cephalic extremity of larva; *d*, anal extremity; *e*, *f*, spiracles. All enlarged. (After Coquillett, U. S. Dept. Agr.)

because they are planted for their roots and not for their delicate stalks, as in the case of celery, which renders the portions above ground more rank and those below ground more tender, while each plant (parsnip and carrot) has a flavor peculiar to itself. Thus it happens that the leaves of parsnip are more affected by the parsnip leaf-miner, while the roots of carrot are preferred by the carrot beetle and carrot rust fly.

The Parsnip Leaf-miner (*Acidia fratria* Loew.).—The economic history of this species begins with 1891, when parsnip leaves in Missouri were quite extensively mined by its larva.

The adults issued June 23. The insect which produces this maggot is shown at figure 118, *a*. It belongs to the same family as the apple maggot or railroad worm, and it will be seen that it is a two-winged fly, with rather prettily marked wings. It is pale dull yellow, and the wings are marked with the same color. The legs are still paler, and the eyes are brown. The head and thorax above bear long, stiff bristles. This fly measures about three-sixteenths of an inch in length, and has a wing expanse at least double that. It ranges from the Atlantic seaboard westward to Missouri and probably farther. Little is known of its life history, but it will probably be found to affect other umbelliferous crop plants and weeds.

REMEDIES advised against the radish leaf-miner (page 154) are applicable.

The Carrot Beetle (*Ligyrus gibbosus* DeG.).—This beetle is the worst insect enemy to carrot and parsnip in this country. It is a native species and of common occurrence along the Atlantic Coast from Long Island to the Gulf and Pacific States and at many points inland. It injures besides the plants specified various root crops and some other plants.

Fig 119. – Carrot beetle. About twice natural size. (Author's illustration, U. S. Dept. Agr.)

The beetle might be mistaken for a May beetle, but the wingcovers are strongly sculptured and coarsely punctate, characters which are wanting in true May beetles (Lachnosterna). The beetle (fig. 119) is of robust form, measuring between one-half and five-eighths of an inch in length, with short legs. The color varies from reddish brown to nearly black on the dorsal surface. Larval injury has been noted, but there is little doubt that the grubs feed also on humus, manure and decomposing roots and tap roots of herbaceous plants. Larvæ have been observed to feed on earth where there

was no opportunity for plant attack. Most cases of injury are due to the operations of the beetles, and damage is more pronounced on young plants, older growth appearing in some cases exempt from attack, owing to its more woody texture. Injury may be accomplished both by hibernated individuals in the spring from April to June, according to locality, and by recently transformed specimens in late summer and autumn.

The species is with little doubt single-brooded. Pupation takes place in an oval cavity in the earth, and hibernation, without much doubt, occurs in the adult condition. The favorite food of the beetle is evidently carrot, and after this corn, parsnip and celery are chosen. Sweet and Irish potato are subject to much damage, as are also sunflower, dahlia, sugar-beet and sometimes cotton. The beetles usually feed beneath the surface; corn is cut just above the roots, and root crops are punctured with holes. Sometimes a crop appears in good condition, judging from the tops alone, but when the plants are pulled injury becomes manifest. Entire plantings have been destroyed by the beetles, and the roots of tubers rendered unmarketable on account of their ravages. They gnaw into the roots of celery, dwarfing and killing the plants, and eat the bark from the root. They sometimes imbed themselves in tap roots and may penetrate the earth to a depth of seven inches. As many as fifty beetles have been found about the roots of a single plant.

Methods of Control.—When this insect is present in large numbers there is little, owing to its working underground, that can be accomplished in the line of control. The beetles are strongly attracted to electric lights, but it is not certain that they could be lured from the field after beginning to feed. It is reported that lime scattered through infested fields has apparently driven the beetles away. After the crop has been harvested, if the insects continue in numbers in the ground, it would

be profitable to turn in hogs or chickens. Crop rotation and other white-grub remedies should be practiced.

The Parsnip Webworm (*Depressaria heracliana* DeG.).—The parsnip webworm is injurious to the seed of parsnip, but for some reason, at least in the experience of the writer, prefers the wild carrot as a breeding plant. The moth is grayish buff, or pale ochraceous, with the fore-wings marked with fuscous (fig. 120, *e*). The larva is pale yellow, greenish or bluish gray, marked with black, piliferous spots, and with bluish black head

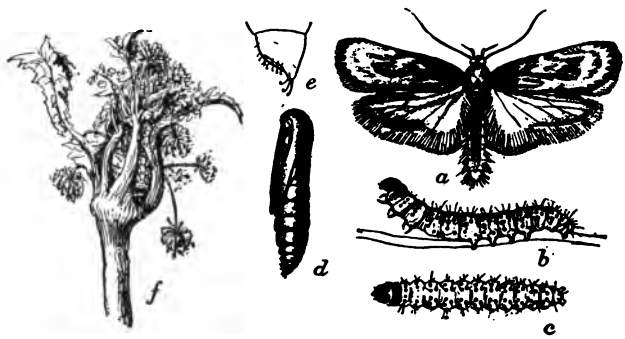

Fig. 120.—Parsnip webworm. *a*, Moth; *b*, *c*, caterpillars: *d*, chrysalis; *e*, anal segment of same: *f*, umbel of parsnip, webbed together by caterpillar. *a*–*e*, Enlarged; *f*, somewhat reduced. (After Riley.)

and thoracic plate, as figured (*a*, *b*). The species is of general occurrence through the northern portions of Europe and our Atlantic States and Canada westward to Michigan. Wild carrot and parsnip, which are altogether too abundant in fields throughout that section, yield it a sufficiency of food and in some years it is difficult to find these weeds that are not affected by the webworm. The larvæ weave the flower heads (*f*) together until these are contracted into masses, with abundant excrement as a covering. Within the domicile thus formed the larvæ dwell. After they have consumed the flowers and unripe

seeds and are nearly mature, they enter the stems, feed on the soft lining, and transform to pupæ. They sometimes destroy newly-sown parsnip, eating the tender leaves, but in attack on older plants they eat the umbels or flower heads and the interior of the stems.

REMEDIES.—A thorough spraying with arsenicals will destroy this webworm. To prevent injury by it avoid planting parsnips in or near waste places which have become overrun with wild carrot.

MISCELLANEOUS INSECTS.—Among other insects injurious to celery the tarnished plant-bug is an important species. It is figured and described on pages 87 and 88. The cotton leaf-bug (*Calocoris rapidus* Say), a species of somewhat similar habits and appearance (fig. 120*x*), also attacks celery and is amenable to the same remedial treatment.

CHAPTER XII

INSECTS INJURIOUS TO SWEET CORN

A GREATER number of species of insects have been recognized as attacking Indian corn than any other plant grown as a vegetable. Although, properly speaking, corn is a field crop, it is also grown for the sake of the unripe ears which are classified as vegetables. What insects will attack field corn will also attack the garden variety, but for present purposes it will not be necessary to treat of any except the more important habitually garden-inhabiting species, and only a few of these need be considered at all in detail. Many of them are general feeders and have been considered in preceding paragraphs.

The corn-feeding species of insects recognized in 1896 were 214 in number, and of these 18 attacked the seed, 27 the root and lower portions of the stalk, 76 the stalk above ground, 118 the leaf, 19 the tassel and silk, and 42 the ear. The remainder attacked the stored product. It is safe to say that at the present writing (1907) at least 350 species are on record as concerned in attack on corn.

The Corn Root-aphis (*Aphis maidiradicis* Forbes).—Concerning this species, Dr. S. A. Forbes wrote in 1896: "No insect affecting corn is more deserving of the attention of farmers and entomologists at the present time than the corn root-aphis. It ranks as a corn pest with the chinch bug and the army worm, less injurious at any one time than these are locally and occasionally, but overtaking them, on the other hand, by its general distribution and the constancy of its attack." This root-aphis does its principal injury while corn is small. The dwarfing of a plant in patches with a yellowing or reddening of the leaves, and

a lack of thrift and vigor, are the outward manifestations of injury. Another indication is the presence of numerous small brown ants which attend this species and without which it probably could not exist.

The corn root-aphis is bluish green, slightly whitened by a waxy bloom. The body is oval, and the nectaries are erect or

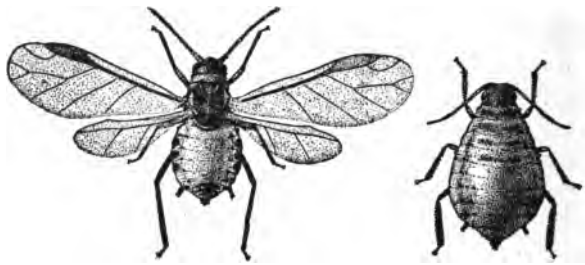

Fig. 121.—Winged viviparous female of corn root-aphis; wingless egg-laying female. Enlarged. (After Forbes)

project slightly backwards. Two of the different forms are shown in figure 121. It is found from Massachusetts to Minnesota and Nebraska and as far south at least as Virginia.

The winged forms migrate to various weeds, among which are smartweed, pigeon grass, mustard, pigweed and plantain.

Economic Treatment.—Our present knowledge of this insect suggests several methods of attacking it. Crop rotation and care not to plant in or near fields of weeds which serve as alternate hosts; the free use of manures and other fertilizers to stimulate the growth of the plants; the disturbing and destruction of the nests of the protecting ants; the destruction of all of the weeds which serve the aphides as food early in the season by plowing, and, in connection with this, late planting of corn.[1] Such measures of procedure may not entirely protect the crops in all localities in all seasons.

[1] These and other remedies are considered in detail by F. M. Webster in Circ. 86, Bu. Entom., U. S. Dept. Agr.

The Southern Corn Root-worm (*Diabrotica 12-punctata* Ol.). —The larvæ of two species of leaf-beetles are among the prominent enemies to the culture of corn by destroying the roots. One of these, the Southern corn root-worm is common nearly throughout the United States, but as its name implies is most destructive in the South. In the case of its attack not alone roots, but underground stalks are injured. The other, known as the Western corn root-worm, is somewhat confined to the middle West, where it would be a very serious pest were it not that farmers generally in that region have adopted a system of rotation which greatly reduces injury. The principal form of its attack is in the interior of the fibrous roots, in which minute, more or less longitudinal, burrows are formed.

The larva of the Southern species is also called in the South the "bud-worm" and "drill-worm." The beetle is commonly known northward as the twelve-spotted cucumber beetle because of its frequenting the flowers of cucumber, as well as squash, and other cucurbits in the interior of which one can usually see one or more dusted with pollen, and the places where they have gnawed the petals, for they are most omnivorous insects and able to subsist on nearly any form of vegetation on which they happen to alight. They are, in fact, to be found in practically all fields of corn and in gardens everywhere.

The beetle is yellowish green, and the wing-covers are marked with twelve black spots (fig. 122, *a*). The length is one-quarter of an inch or a little longer. The larvæ (*c*) are slender, thread-like, delicate and soft bodied, and white or yellowish in color.

The twelve-spotted cucumber beetle inhabits that portion of America lying between the Atlantic seacoast to the base of the Rocky Mountains, and from Canada to Mexico. It is a very common species and most destructive in the South, where injury is accomplished by its root-worm form as far northward as Maryland and Virginia.

The adult is practically omnivorous, its known food materials are legion, and include besides the pollen and flowers and partly matured kernels of corn, wheat and oats, the foliage of alfalfa, crimson clover, cotton, rye and tobacco. Of vegetables it attacks all forms. It frequently injures the fruit of melon and other cucurbits. Larvæ or pupæ have been observed at the roots of corn, wheat, rye, millet, beans, rudbeckia

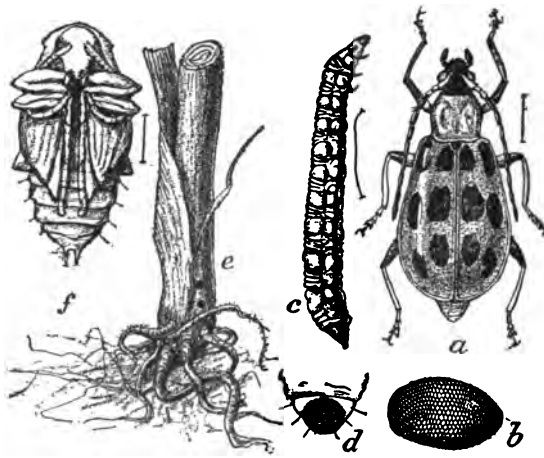

Fig. 122.—Southern corn root-worm. *a*, Beetle; *b*, egg; *c*, larva; *d*, last segment of same; *e*, section of cornstalk showing holes made by larvae; *f*, pupa. *a*, *c*, *f*, Considerably enlarged; *b*, *d*, more enlarged; *e*, reduced. (*a-d*, After Riley; *e*, *f*, redrawn, U. S. Dept. Agr.)

and sedges. In fields of corn this root-worm gives origin to the loss of roots, injury varying according to the age of the corn and severity of attack, and somewhat also upon the condition of the weather, and even of the soil. Injury is manifested in various ways: from the death of a plant to retardation of growth, or to what is termed "spindling," or a yellowish, unhealthy look. In plants six inches or less in height the perforations of the stalk (fig. 122, *c*) are character-

istic, and usually show just below the surface. This is accomplished by more or less withering of the plant, which is frequently killed outright by the destruction of the central tuft of growing leaves. Frequently plants are destroyed almost as soon as sprouted. Should the plants survive ordinary attack they are apt to fail to produce mature ears. If plants which are suspected of harboring this species are pulled up, the root-worms can be dislodged, and it is not difficult to distinguish them from other forms of insects found in the same locations, with the exception of the western corn root-worm, which, however, seldom occurs in the same regions.

The beetle is one of our earliest as well as latest species. Indications are that at least two and perhaps three generations are produced annually in the District of Columbia, and probably four in the insect's more southern range. Eggs are laid at the base of the insect's food plant and have been observed by the writer to hatch in six and seven days in cool May weather.

REMEDIES.—We cannot reach the insect, to any extent, by means of poisons and their use on growing corn is impracticable. Therefore, we must have recourse to farm methods. Injury to corn is greatest when seed is planted in bottom lands, and if planting is necessary in such locations it should be done late, in the Gulf region by the first of May, or attack may be so distributed that damage will be inconsequential, by dropping about ten grains of seed-corn in each hill. Of greater importance, however, is judicious crop rotation. Numbers of crops are not injured by the Southern corn root-worm, and can be used as alternates. Of these are cotton, buckwheat, smaller grains, and vegetables other than beans and cucurbits. In the occurrence of the beetles on cucurbits remedies advised against the striped cucumber beetle should be used. (See page 158.) On beans a spray of arsenate of lead should be employed.

The Western Corn Root-worm (*Diabrotica longicornis* Say.). —Notwithstanding the general employment of crop rotation as a means of preventing losses by this species, inflicted injuries are reckoned by millions of dollars annually. Thus in 1885 the damage to corn in 24 counties of Indiana was estimated at $2,000,000. Corn is the only food plant of the larva, but the beetles are somewhat more choice in food habits than the Southern species. In the experience of the writer and some others, they are partial to thistle blossoms, in which they

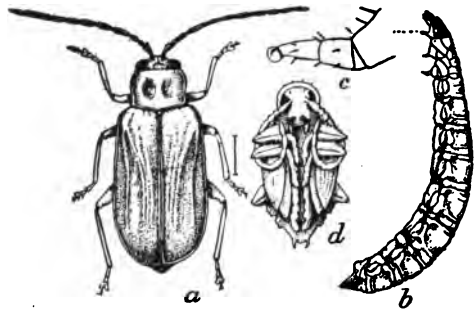

Fig. 123.—Western corn root-worm. *a*, Beetle; *b*, larva, from side; *c*, leg of same; *d*, pupa. All much enlarged; *c*, more enlarged. (Author's illustration, U. S. Dept. Agr.)

deeply imbed themselves, to sunflower and goldenrod, and are less frequently found on cucurbits. The beetles do some damage to corn by feeding on the pollen and gnawing the silk and tassels, thus to a certain extent preventing cross-fertilization and causing a partial blasting of ears. Other plants such as ragweed and smartweed are frequented for the sake of pollen. In late fall and early winter the beetles have the same habit as the twelve-spotted and striped cucumber beetles of gnawing into squash and pumpkin in the field.

This species is evidently single-brooded. The beetles occur in the field, like the Southern species, until November, in open winters as late as the middle of December, which is, in the writer's opinion, proof positive that the beetles hibernate, but

as a rule the species passes the winter, according to Forbes, in the eggs which are deposited in the earth.

The developing larvæ live entirely beneath the surface, mining the fibrous roots, and seem capable of traveling from one root to another; pupation also takes place underground. The beetles of the new generation begin to issue during the latter part of August.

PREVENTION AND REMEDY.—This species is more readily controlled than the Southern corn root-worm; injury can be prevented by simply following crop rotation. Since the insect feeds in its larval condition on corn alone, the planting of infested land to other crops leads to its starvation. It is imprudent to plant corn in fields or meadows in which the beetle has been observed in abundance in autumn of the previous year. Another measure is recommended, as a general farm practice, the maintenance of the fertility of the soil by the use of manures and other fertilizers. Although this does not diminish attack, it enables the plant to withstand injury.

Fig. 124.—The calloused corn bill-bug (*Sphenophorus callosus*). (Author's illustration.)

THE CORN BILL-BUGS

Bill-bugs, like wireworms and white-grubs, follow the planting of corn in sod and bottom land or in the immediate vicinity of streams in which sedges, rushes and similar wild vegetation grow rankly. They are an adjunct to the reclamation of swamp tracts and receive their name from the long "bills" which they bear. They are snout-beetles and related to weevils and curculios. Several species are troublesome in corn-growing regions, and were it not that they are exceptionally periodical they would take high rank with the important enemies of this

crop. A year or two after the first attack, the beetles usually disappear, since only a few species live in the larval stage on corn. The larvæ feed at the roots and in bulbs of the forms of vegetation that have been mentioned, which include nut-grass and various true grasses such as timothy. The greatest injury is due to the perforation of stalks of corn just at or below the surface when plants are only two or three inches high. The beetles sink their beaks deeply through the unfolded blades so that when these unroll little rows of both round and elongate longitudinal holes are left as evidence of earlier attack. As with injury by root-worms and some other insects which live in more or less concealment at or below the soil surface, close scrutiny is necessary in order to detect bill-bugs, and damage which is usually first manifested by the wilting and dying of plants and their stunted growth is apt to be attributed to other causes. The habits of these insects, in common with other snout-beetles when disturbed, of drawing their antennæ and legs closely to their bodies, and of their bodies being frequently more or less covered with dirt, are of assistance in their concealment. A common injurious form is shown in figure 124.

The Southern Corn Bill-bug (*Sphenophorus maidis* Chittn.) is one of the most pernicious bill-bugs, and a good example of a species that lives in its larval as well as adult stage on corn. It is most destructive in lowlands and occurs in the Gulf region and in Kansas. Of the habits of this species Dr. L. O. Howard says substantially:

"Wherever the larva had reached full size, the pith of the stalk was completely eaten out for at least five inches. Below ground, even the hard, external portions of the stalk were eaten through, and in one instance everything except the rootlets had disappeared, and the stalk had fallen to the ground. In a great majority of instances a single larva was found in a stalk, but in a few cases two larvæ were at work. In no case had an ear filled on a stalk bored by this larva. The stalk

was often stunted and twisted, and the lower leaves were invariably brown and withered."

From examination of numbers of stalks it is evident that eggs are laid in them near the soil surface, and the young larvæ usually work downwards. The presence of larvæ in the stalks proper is apparently only after the roots and the pith below ground have been exhausted. The beetle (fig. 125, *c, d*) is black, and has the thorax marked with three raised lines. The length is about half an inch exclusive of the snout, which measures about one-sixth of an inch. The larva is of about the same

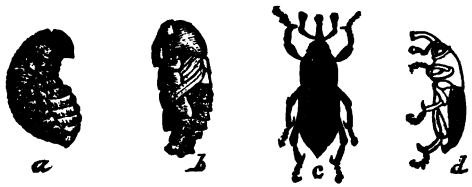

Fig. 125.—The Southern corn bill-bug. *a*, Larva; *b*, pupa; *c*, beetle, from above; *a*, same from side. All slightly enlarged. (From Riley, U. S. Dept. Agr.)

length as the beetle, nearly white, of the peculiar curved form shown at *a*, the head being a little darker and the mouth-parts still darker.

The Northern Corn Bill-bug (*Sphenophorus zeæ* Walsh) is somewhat restricted to the north as regards injuries. The adults alone injure corn, the larvæ subsisting on the roots and bulbs of timothy and other grasses. In 1891 the writer investigated an invasion of this species in Chester County, Pennsylvania, where the beetles were attacking newly-planted corn just beneath the surface. As was surmised before visiting this point, a stream of water was running close at hand in the marshy soil where rank vegetation grew in profusion, including different forms of sedges, rushes, weeds and wild grasses, the obvious original starting place of the insect. The principal damage was done to cornfields located from fifty to one hundred feet above the creek

bed. In one field not a single plant had escaped attack. Approximately 50 per cent. of the plants had been killed outright, and 25 per cent. of the remainder were so severely damaged as to necessitate replanting. In some fields a second replanting had been necessary. In the latter days of May the bill-bugs were in the height of their work of demolition, and had nearly ceased by the second week of June.

The Clay-colored Bill-bug (*Sphenophorus æqualis* Gyll.)[1].—This species (fig. 126) resembles the preceding in depredating

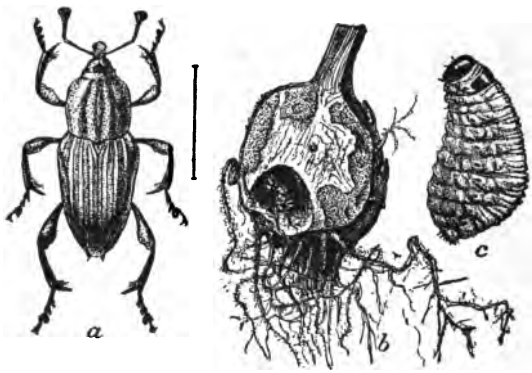

Fig. 126.—Clay-colored bill-bug. *a*, Beetle; *b*, work in rush bulb; *c*, larva (Insect Life, U. S. Dept. Agr.)

on corn only in the adult stage, its larva developing in the bulbs of club rush and related plants. It is the largest of our injurious corn-feeding species of this group.

METHODS OF CONTROL

Injury to other crops than corn by bill-bugs is comparatively insignificant, and the same holds of the larvæ. The beetles are the occasion of the greatest losses when corn is first planted and their amazing vitality makes it difficult to combat them with poisons which are practically inert.

[1] Mentioned in economic literature as *Sph. ochreus* Lec.

Bill-bug injury in general may be avoided by not planting corn in land already liable to be infested, such as swampy ground, river bottoms, or in soil in which rank grasses and sedges are growing. Before planting, such ground should be thoroughly broken up and grown to some crop which the beetles will not injure. Bill-bugs so far as known injure only corn, rice, timothy, nut-grass and other grasses, and occasionally smaller grain. Cotton, tobacco, buckwheat, potatoes or other garden vegetables, or other crops than those mentioned as susceptible to bill-bug attack, will serve as alternates.

Direct remedies are possible against bill-bugs whose larvæ also injure corn. One of these consists in plowing up and burning infested stubble, when the larvæ are present in such numbers that the ruin of a crop is assured. This should be done late in July or early in August for most localities, before the insects have matured and issued from the stalks as adults. Some species, *e. g.*, the Southern corn bill-bug, pass the winter as adults in the stubble and for these burning over the fields as soon after harvest as possible is indicated. In the case of the Northern bill-bug do not plant corn after timothy.

The Common Stalk-borer (*Papaipema nitela* Gn.).—This insect enjoys the distinctive designation of *the* stalk-borer, but it has numerous other names of which are the heart-worm and potato stalk-borer. Although a general feeder, it is quite as commonly found attacking corn as other crops, hence may be mentioned in connection with the two species that have just been considered.

The moth (fig. 127, *a*) is medium gray-brown or fawn color, and marked as shown. The growing larva (*b*) is peculiar in having the first three or four abdominal segments suffused in such a manner as to give it the appearance of being diseased. The mature larva measures about an inch and a half and has more or less the appearance shown at *c*. The abdominal segment of the larva is shown at *d*, while at *e* is shown the female

chrysalis. This stalk-borer is credited with doing injury to the stalks of tomato, potato, spinach, cauliflower, eggplant, pepper, dahlia, aster, lily, spiræa and salvia; and to the twigs

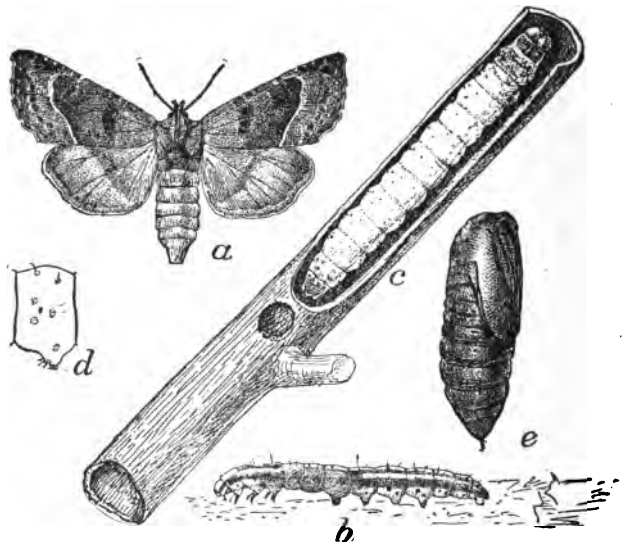

Fig. 127.—Common stalk-borer. *a*, Female moth; *b*, half-grown larva; *c*, mature larva in injured stalk; *d*, abdominal segment of same; *e*, pupa. All somewhat enlarged (Author's illustration, U. S. Dept. Agr.)

of blackberry, currant, apple and peach, as well as to the stems and stalks of wheat and corn.

When the borer infests the crop plants that have been enumerated the portions above the point of attack in the stem wilts and finally withers before breaking down. In the case of infestation to such rank-growing vegetation as ragweed (*Ambrosia trifida*), cocklebur and the like, several larvæ of this, as well as other, species may be present without seeming harm to the weed's growth. In large stems the larva normally passes its entire existence in a single plant, but when small grains are attacked it deserts one for another.

The different species of this genus of which there are many seem to agree in transformation to pupæ in the larval burrow, the last act of the larva before making its final moult being the construction of a large opening about one-fourth inch in diameter for its escape when the moth condition is attained. The pupal period lasts from two to four weeks and the moths issue sometime in September or October.

REMEDIES.—In ordinary cases this stalk-borer can be held in check in the small vegetable garden which it has invaded by pulling and burning infested plants. As the moth lays her eggs on the stems in September, fall plowing is advisable, or raking up and burning all forms of vegetation, especially ragweed.

In large fields it is difficult to combat, but its injuries may be prevented by care in keeping down, and by *promptly* destroying, the weeds after they are pulled or hoed out during the growing season. If weeds are left to dry the striped caterpillar of this species will desert them and enter cultivated plants. Crop rotation is advisable where this can be conveniently practiced, and such plants as cabbage, radish and the like, onions, beets, asparagus and celery are suggested as alternates. When the plants are sprayed with arsenicals for other insects this will operate to a certain extent against this stalk-borer.

Owing to the frequency of attack on the borders of cultivated fields, it might be found a measure of some value to permit the ragweed to grow at these points as lures to the insects, and destroy them before September, *i. e.*, before the moths have issued to lay their eggs for another generation. Fall plowing should be practiced or the fields burned over late to destroy the eggs.

The Larger Corn Stalk-borer (*Diatræa saccharalis* Fab.).—This pernicious corn pest, although a southern insect, in a succession of seasons which favor its development sometimes works northward as far as Delaware and New Jersey, where it is occasionally-injurious, and westward to Kansas. It is identical

with the sugar-cane borer of the South. In seasons of abundance a loss of 25 to 50 per cent of the crop is not unusual. Sometimes a stalk contains as many as 30 or more holes drilled by this borer. In addition to corn and sugar-cane, the borer has been noticed on sorghum and gama or sesame grass.

The moth or parent of this stalk-borer is extremely variable as regards size and markings. There is an individual variation from an inch to nearly an inch and a half in wing expanse.

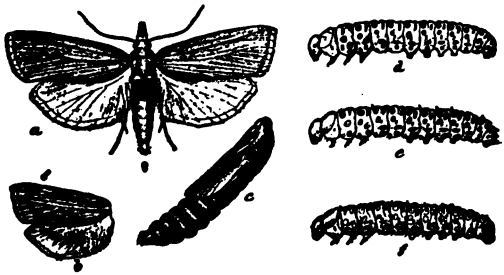

Fig. 128.—Larger corn stalk-borer. *a*, Female moth; *b*, wings of male; *c*, pupa; *d*, *e*, *f*, larvae. Near natural size. (After Howard, U. S. Dept. Agr.)

The fore-wings are pale ochreous with fine darker longitudinal lines, with a discal dot and marginal ones arranged as shown (fig. 128, *a*, *b*) in the illustration. The larva when full grown measures three-fourths of an inch or a little longer. Some are white and some strongly marked with black or brown arranged in round and elongate spots. This variation is well shown in figures *d*, *e*, and *f*.

Dr. L. O. Howard was the first person to investigate the habits of this insect in the United States. The moths appear in spring, and soon after young corn comes up lay eggs on the leaves near the axils, and the borers on hatching penetrate the stalks near the joint, tunnelling usually upward through the pith. The borer grows rapidly, and frequently leaves a stalk at one place and enters at another, making several holes in the

course of its lifetime. When full fed it penetrates to the outer surface of the stalk and makes a hole from which in due time it issues as a moth. Figure 129, *a*, shows a stalk infested by the first generation of borers, and *b* a stalk cut open to show the larval burrow in which the pupa is resting. The

Fig. 129.—*a*, Stalk infested by first generation of borers; *b*, stalk cut open (redrawn)

pupa state is assumed in Virginia from the middle of July on, and the moths issue ten days to two weeks later. The eggs for the second generation are deposited soon afterwards on higher grown stalks, and the larvæ are mature by harvest time. The injury accomplished by the second generation consists largely in the weakening of the stalk so that it is readily blown down by winds, whereas damage by the earlier generation pre-

vents the maturing of the ears. The borers of the second generation (most of them) pass the winter as larvæ. The periods of this species in a given locality are tolerably regular, hence it follows that early corn is more frequently infested than later plantings, and corn planted after the first of June is less apt to be seriously infested. Fortunately severe cold spells kill off the insect from time to time in the North, and the writer has seen corn fields practically ruined and a year or two later has been unable, after hours of search, to find more than one or two individuals on the same farms.

REMEDIES.—If planters would be more careful in methods of cultivation this corn stalk-borer would have no chance to propagate in the North. In regions infested by this insect corn should not be planted until after the first of June. Stripping or pulling corn for fodder, so prevalent in the South, and leaving the bare stalk with ear attached, is a bad practice, not alone on account of this, but other insects, and should be discontinued. Treating of the species only as a sugar-corn pest, it should be stated that the same remedies should be practiced on field corn, sugar-cane and sorghum to prevent the insect spreading from one field to another. Butts of corn should not be left in the field after harvest, as they afford safe places for larval hibernation, but should be dragged off and burned as promptly as possible.

Rotation of crops, if practiced over considerable areas, would greatly diminish the numbers of this pest, and if pursued in connection with clean farming severe losses would be averted. Observation has shown that the average damage to crops planted upon land which was in corn the previous year reached 25 per cent, while the average to corn planted on sod land was only 10 per cent, even where this land was close to former corn land.

The Smaller Corn Stalk-borer (*Elasmopalpus lignosellus* Zell.).—This stalk-borer was first observed depredating on corn

in the Southern States not earlier than 1878, and years later injurious occurrences in stems of beans and peanuts were reported. The moth is exceedingly variable. The fore-wings are pale yellow or ochreous, and the outer border, toward the ends, consists of dark, purplish scales. The female (*b*) has fore-wings varying from reddish to nearly black and the

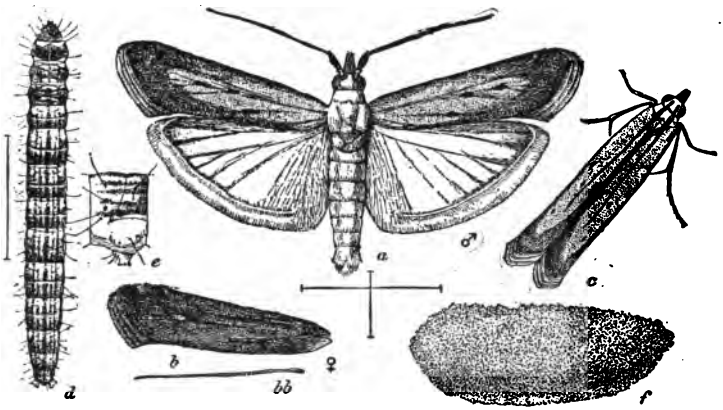

Fig. 130.—Smaller corn stalk-borer. *a*, Male moth; *b*, fore-wing of dark female; *bb*, antenna of female; *c*, male at rest; *d*, larva; *e*, ventral segment of larva from side, much enlarged; *f*, cocoon. All except *e* three times natural size. (Author's illustration, U. S. Dept. Agr.)

hind-wings transparent, silvery fuscous. The larva (fig. 130, *d*) is half an inch or more in length when mature, and a most beautiful object when viewed through the lens; pale green, marked with nine reddish brown longitudinal stripes, arranged in transverse bands. Transformation takes place in a cocoon formed of sand or dirt (fig. 130, *f*).[1]

This is a tropical species, occurring from the Gulf as far north as North Carolina. It also inhabits Central and South America.

"While chiefly injurious to young corn, destroying many

[1] A full account of this species is given in Bul. 23, Bu. Entom., U. S. Dept. Agr., pp. 17–22.

stalks and necessitating the replanting of many hills, the smaller stalk-borer works throughout the entire summer and fall, and, as late as October, cuts the toughened stalks of the late corn to such an extent that they are easily blown to the ground, and the ears are often rendered useless by contact with the wet earth. The principal work of the borers is done at the surface of the ground, although they are often found just above or below this point."

Fig. 131.—Cornstalk showing work of smaller corn stalk-borer. Natural size. (After Riley, U. S. Dept. Agr.)

Injury to the root stalk extends, occasionally, to the depth of two inches. In attack on beans the larvæ also work in the earth, holes showing where they force out their excrement or make their escape. In one case of infestation upwards of 90 per cent. of a planting was destroyed. Where peanuts have been injured, as much as half a crop was destroyed, the larvæ sometimes penetrating the shells of the tubers. When about to transform, this borer leaves the stalk and spins an oval, somewhat flattened cocoon, which becomes covered with earth or excremental pellets.

REMEDIES.—As this stalk-borer hibernates in all stages—larva, pupa and adult—a practical remedy is difficult to find. The pulling up and burning of infested material as early as possible after the crop is removed, and rotation with some crop that would not be affected by this species, are desirable. The smaller cereals, sweet potato, cotton, cucurbits. potato, tobacco

and asparagus are suggested as alternate crops. It does not seem possible that the insect could be reached with insecticides with profit. Kerosene emulsion or bisulphid of carbon, however, should be tried.

This brings us to the subject of the insects injurious to the ears. Of these the corn-ear worm is the most important.

The Corn-ear Worm (*Heliothis obsoleta* Haw.).—The maturing ears of corn and pods of beans and cowpeas are often found bored full of holes and the seed within devoured. The insect most often concerned in damage of this nature is figured herewith. It is a well known enemy of corn, cotton and tomatoes, whence it has received the vernacular names corn-ear worm, bollworm, and tomato fruit worm. It is a species of wide distribution and destructiveness, but whether indigenous to this country or imported is not known. In addition to the crops mentioned, this species injures tobacco, pumpkin, squash, melon, pepper, okra and other vegetables. Even if only a single hole is made in an ear of corn, the damage is apt to be considerable, as the remainder is likely to become more or less decomposed and access is afforded to other insects and to rain. The same is true of the injuries by this insect to other fruits, to tomatoes, beans, etc.

Fig. 132.—Corn-ear worm (*Heliothis obsoleta* Haw.) and characteristic injury to ear of corn. (Quaintance, U. S. Dept. Agr.)

The adult moth is ocher yellow, more or less variegated with

blackish markings, and arranged as in figure 132*x*, *a*. It measures about an inch and a half across its expanded fore-wings. The ear worm itself varies greatly in color, different shades of pink, purple and green prevailing. A dark striped form is shown at *b*.

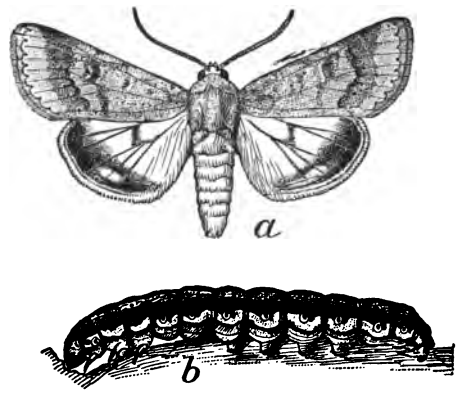

Fig. 132*x*.—Corn-ear worm. *a*, Moth; *b*, larva (Author's illustration, U. S. Dept. Agr.)

Injury to young corn by the first generation is confined largely to the "bud," and becomes apparent as the ragged or shot-holed leaves unfold. It is rarely serious in extent. Likewise, injury by the second generation is comparatively insignificant, but the third generation, affecting roasting ears, may be the cause of much loss.

Remedies.—No practical means, aside from farming methods, such as late fall or winter plowing, and judicious rotation of crops, have, as yet, been discovered for reducing injury to corn. The remedy which gives most promise of controlling this pest farther north consists in planting, where weather conditions permit, several days earlier than customary, and taking chances on the weather which may follow. A few days' difference may save considerable corn. In any case, it is advisable to plant as early as possible, since, as a rule, the later the corn is planted the more injury by the ear worm.

The Fall Army Worm (*Laphygma frugiperda* S. & A.).—If it were not for its extreme periodicity of attack the fall army worm would rank high as a corn pest, as it affects not

only the foliage, but bores into the ears when they are quite young, destroying them utterly. The writer has seen fields in Virginia badly attacked in this manner, the outward appearance so closely simulating that due to the corn-ear worm as to deceive all who witnessed the injury. It is discussed more fully on page 56 on army worms.

The Brown Fruit-chafer (*Euphoria inda* Linn.).—The ears of green corn, ripening fruits and some flowers are subject to the attack of the stout hairy brown beetle figured in 133. The length is half an inch or more. The larva (*d*) is a white-grub, with the lower moiety of the body of a dull leaden hue from the contents of the abdomen. Transformation to pupa takes place in a cocoon smooth within and irregular on the outer surface. This species occurs practically everywhere in the United States east of the Rocky Mountains.

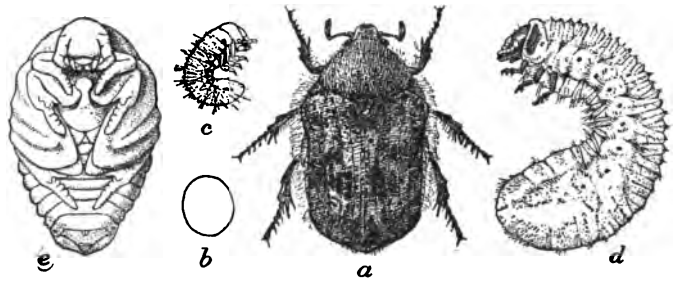

Fig. 133.—Brown fruit-chafer. *a*, Beetle; *b*, egg; *c*, *d*, larvae; *e*, pupa. All enlarged (Author's illustration, U. S. Dept Agr.)

Injury is confined to newly transformed beetles in autumn. The food of the larva is manure, humus, and similar material, and not healthy roots, as once supposed. The beetles feed naturally on sap exuding from wounds in trees, and juices of overripe or injured fruits or other vegetable growth, and have an especial fondness for ears of ripening corn, particularly sweet corn, and even bore through the husks to the kernels within. The beetles devour flowers of different fruits, and

attack fruit exposed for drying. The large size of these beetles and their habit of assembling in numbers render them at times an object of much apprehension. About the District of Columbia the beetles may be seen in April flying low, with a loud humming sound like a bumblebee. The new generation begins to appear toward the end of August, the date varying with locality and season, and after they have fed for two or three weeks they go into winter quarters. A single generation is produced in a year.

REMEDIES.—Hand methods are available remedies for the beetles when they occur in abundance. The use of insecticides on ripening fruit is practically out of the question. During the heat of the day, particularly in bright sunlight, the beetles are active, but in the shade when feeding they can readily be captured by jarring them from the plants on which they occur into bags or nets. Fortunately, the species is only intermittently troublesome, and therefore it need not cause serious alarm.

Cutworms and Other Caterpillars.—The fondness of cutworms for young corn is proverbial, and rarely is a corn field entirely exempt from the presence of these ancient foes of man. Sweet corn is particularly affected by these ravagers, but as a rule, owing to the later planting of corn, it does not suffer so great injury as plants that are reset from forcing houses, such as tomato, cabbage, and the like. Nearly all other field and garden caterpillars, including the fall army worm and garden webworm, with general feeding tendencies, will attack corn when more preferred plants are lacking.

The corn cutworm (*Noctua c-nigrum* Linn.) better known as the spotted cutworm, is one of our commonest and most destructive species, and resembles the variegated cutworm treated on pages 53 and 54, being cosmopolitan, nearly omnivorous, a climbing species, and traveling in armies like the army worm. The cutworm (fig. 134, *b*) is pale brown or gray, sometimes whitish, with green or olive tints, and measures

fully about an inch and a half. The moth has brown forewings, tinged with reddish or purplish, and marked as figured (fig. 134, *a*). In addition to corn and cereals, this species affects cabbage, turnip, pea, carrot, tomato, celery, rhubarb and other vegetables.

Cutworm remedies are discussed on page 54.

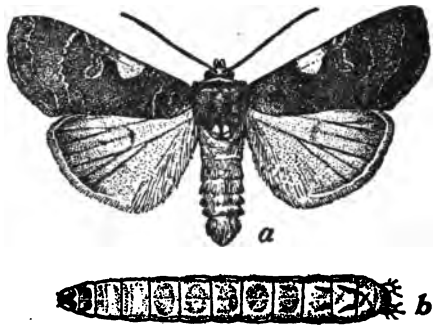

Fig. 134.—Spotted cutworm. *a*, Moth; *b*, larva. Somewhat enlarged (Author's illustration)

Flea-beetles.—A considerable number of flea-beetles are commonly found on corn, but of these the two species mentioned below are more particularly attached to this crop. All species are most troublesome on young plants.

The brassy flea-beetle (*Chætocnema pulicaria* Mels.). Injury to sweet corn by flea-beetles is sometimes complicated by the presence of two species. The present is the more abundant of the two in most localities, and as it is considerably smaller, it is probable that it is usually the cause of the trouble attributed to it. It measures less than one-twentieth of an inch, and is of oval, convex form, with shining surface, having a faint greenish-bronze lustre. The legs are usually brownish testaceous, and the thorax bears little trace of polish (fig. 135).

Fig. 135.—Brassy flea-beetle. For size see line at right. (Author's illustration, U. S. Dept. Agr.)

It occurs in Pennsylvania, Maryland, Virginia, District of Columbia, North Carolina, Texas and Colorado.

The toothed flea-beetle (*Chætocnema denticulata*) resembles the species just figured. It is, however, much larger, measuring fully twice as long, or about one-tenth of an inch, is more robust, somewhat irregularly oval, the entire surface brightly bronzed and slightly brassy.

It is distributed from New England to Florida, Texas and Montana, and is found even in California.

REMEDIES.—These two species can be destroyed by arsenicals and other remedies advised in the discussion of flea-beetles (pages 65 and 66).

Other Insects.—For a consideration of other insects which injure corn, such as wireworms and white grubs, see pages 73 to 83.

A species of wireworm common in the corn fields of the South is illustrated in its several stages in figure 135*x*.

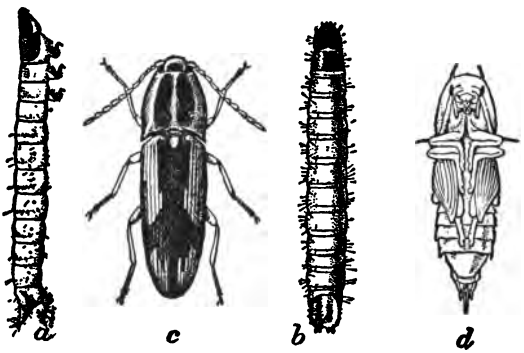

Fig. 135*x*.—Southern corn wireworm (*Monocrepidius vespertinus*) *a b*, Larva; *c*, beetle; *d*, pupa—about three and one-half times natural size. (Author's illustration, U. S. Dept. Agr.)

CHAPTER XIII

INSECTS INJURIOUS TO POTATO AND SIMILAR VEGETABLES

SOLANACEOUS vegetables include potato, tomato, eggplant, pepper and cultivated species of Physalis, one of which is known as husk tomato. A moderate number of insects are attached to these plants and most of them affect tobacco, besides weeds of the same family.

The most important potato insect in the economic sense, is the Colorado potato beetle, followed by half a dozen or more destructive blister beetles, and less important species of the same group. Numerous species of cutworms select the tomato and potato as their particular prey and the latter plant is favored by several forms of flea-beetles. Among other insects which take their name from the potato are the potato stalk-weevil and potato stalk-borer, potato tuber moth and potato scab gnat. The two species last mentioned injure particularly the stored product, and several other insects attack the tubers in the ground. Of such are wireworms and certain cutworms, *e. g.*, the variegated cutworm, when they become unusually numerous, and white grubs.

All of the general feeders which have been mentioned are treated in introductory chapters. Some of the blister beetles, more particularly the striped blister beetle, are known as old-fashioned potato beetles. In the Southwest there are numerous species of these insects which affect the potato crop in that section. One of the potato stalk-borers is treated under the name of "the common stalk-borer" in the chapter on corn insects (page 199).

Three species of aphides commonly occur on potato and are apt also to attack tomato, eggplant, and other Solanaceæ. The same is true of mealy-bugs. The aphides include the common "green fly,"[1] "black dolphin,"[2] and "melon louse."[3] Some forms of tree-hoppers and related species, and thrips also, attack these plants.

The Colorado Potato Beetle (*Leptinotarsa decemlineata* Say.).—Soon after the Civil War the Colorado potato beetle created quite as great consternation as the San Jose scale at the present time. There is perhaps no more familiar insect to those who live a rural life, and every country boy or girl knows its two active stages. It is still one of our worst pests owing to the fact that we must wage more or less perpetual warfare to suppress it. In its early days there seemed to be no check to its increase, but in the course of years many natural enemies have learned to prey upon it, until in many localities it is largely kept in abeyance by such agencies. It is of peculiar interest as being the direct cause of the use of Paris green upon edible plants. Fortunately, with a little knowledge of the habits of this insect, the use of arsenicals and the friendly assistance of natural enemies, the insect can now be held in practical subjection, otherwise it would be one of the greatest scourges of this country.

This insect is so well known that a description is hardly necessary, but that there may be no danger of confusing it with blister beetles and others of similar habits, with which it is occasionally associated, a few words of description may be given. The beetle is of the robust form shown in figure 136, *d, d,* ochre yellow in color, with the wing-covers ornamented with ten black lines. The eggs are oval and orange colored, and are deposited in masses of a dozen (*a, a*) or more on the lower surface of the leaves. The larvæ or "slugs" (*b, b*) are

[1] *Rhopalosiphum dianthi* Schrk. [2] *Aphis rumicis* L. [3] *Aphis gossypii* Glov.

as well known as the beetles. They are soft, slimy, red-colored, evil-looking creatures.

The Colorado potato beetle was first associated with injury to potato in 1865, prior to which time it had fed on the sand bur.[1] With the advance of civilization westward and the cultivation of potato in the vicinity of its native home, the insect

Fig. 136.—Colorado potato beetle. *aa*, Eggs; *bb*, larvæ; *c*, pupa; *dd*, beetles—all enlarged about one-fourth; *e*, wing-cover—much enlarged. (After Riley)

acquired the habit of feeding on this more succulent plant. By 1869 it had found its way to Ohio and the year following was very destructive throughout the Northwest, continuing its eastward march at an increasing rate.

Since that time its migration eastward, northward and southward has continued. Its progress eastward was accomplished largely by flight, as the writer had occasion to observe when a resident of Cleveland in the early days of its invasion of the Buckeye State. With outspread wings numerous individuals could be seen on bright days in spring and early summer, being carried with the winds directly eastward. By the cen-

[1] *S. olanum rostratum.*

tennial year the Colorado potato beetle occupied an area composing more than a third of the United States.

Beetles and larvæ are destructive in nearly equal proportion. In its early occurrence as a pest it not only caused entire losses of crops, but sometimes destroyed the potato yield of whole counties, and large portions of some States. Indeed, at one time it materially affected the market price of potatoes by direct depredations and in discouraging farmers in the cultivation of this crop. At the present time growers recognize the fact that the control of the potato beetle is a part of the routine of the culture of this tuber, and that its natural enemies assist in a remarkable degree in reducing its numbers. The insect is nearly always found on its wild plants wherever they occur and it practically feeds on all solanaceous crops and weeds, including tomato, tobacco, ground cherry, thorn apple, and Jamestown weed, henbane (hyoscyamus), belladonna, petunia, and Cayenne pepper. The tender leaved varieties of potato are most affected, while those with less tender foliage, of the "Peach Blow" and "Early Rose" type, are comparatively immune.

The beetle hibernates under ground and is credited with being double-brooded with sometimes a third partial generation, which hibernates in the pupal condition. The beetles appear early in spring, issuing soon after the first thawing of the ground, at this season flying during the more heated portions of warm days, making aerial journeys of considerable extent. Larvæ hatch in from less than a week to a little later, according to the prevailing temperature, and in two or three weeks usually acquire maturity, when they undergo transformation to pupæ and subsequently to beetles in cells which the larvæ form in the earth. The insect is to be found in practically all stages during the summer months, and as long as there are suitable plants for food. A single female is capable of producing from five hundred to a thousand eggs. The entire life

cycle from egg to adult may be passed in a single month, and the last generation of beetles issues early in autumn and re-enters the earth for hibernation. Fluctuation in numbers of the Colorado beetle is noticeable at least locally every season, and is largely attributable to the activity of its insect enemies and to atmospheric conditions. Upwards of 30 species of insects prey upon this beetle. One of the most important of these is a predaceous ground-beetle, *Lebia grandis* Hentz (fig. 137).

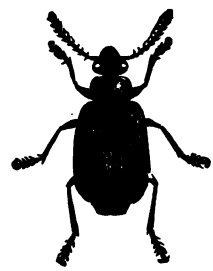

Fig. 137. — *Lebia grandis*. Enemy of the potato beetle. (Marx *del.*)

REMEDIES.—No other methods are necessary than the free use of Paris green or arsenate of lead and mechanical means for its destruction.

Hand-picking, if employed early in the season, is of great value, but where large areas are planted other methods are necessary. Gathering the beetles and their larvæ in pans containing a little water on which a little kerosene is floating, is an effective remedy. Methods of preparing and applying the arsenicals are given in the chapter on insecticides.

If the grower can secure the cooperation of his neighbors in the destruction of this pest, and will also kill the insects on wild plants, much can be done toward limiting its numbers in small areas. It seldom, if ever, migrates as formerly, and there is not so much likelihood of reinfestation from a distance. It is always wisdom to keep down weeds, and in the treatment of the present insect, if they were cut before seeding, it would serve a dual purpose in preventing the increase of weed as well as insect. The susceptibility of the "slugs" to extreme heat, indicates that the remedy for the asparagus beetle of brushing them from the plants on hot dry days will be effective.

The Potato Flea-beetle (*Epitrix cucumeris* Harr.).—Much injury to potato is inflicted by flea-beetles which attack most

solanaceous plants, of which they are specific enemies, riddling the leaves with punctures and causing them to die, thus weakening the vitality of the plants, while the larvæ of some of them feed at the roots and do injury in this manner. The most important of these insects are three species known respectively as the potato, the eggplant and the tobacco flea-beetles, their names indicating the plants which they most often injure. This potato flea-beetle (fig. 138) is the most destructive of this group. The name "cucumber flea-beetle" was given it by

Fig. 138.—Potato flea-beetle. Much enlarged. (Author's illustration, U. S. Dept. Agr.)

Fig. 139.—Egg-plant flea-beetle. Greatly enlarged. (Author's illustration, U. S. Dept. Agr.)

Harris, who found it very destructive to cucumber, eating the seed leaves and destroying the plant. It is very minute, measuring only 1/16 inch in length, perfectly black, with clay-yellow antennæ and legs, and there is a deep transverse furrow at the base of the thorax. This species is generally known from Massachusetts to Georgia, and westward to California.

Injuries are most apparent, however, in the North. The larva is confined to solanaceous plants for food, and is the cause of "pimply" potatoes. When this trouble attracted attention in New York in 1894, potato buyers were on the lookout for potatoes so affected, offering a reduced price for them. Frequently such sold for five cents a bushel below the regular market price. The so-called "pimples" were accompanied by

"slivers," and it was some time before it was ascertained that they were due to the slender white grubs of this flea-beetle. Eggplant, tobacco and tomato are affected less as a rule than potato, but the beetles also attack plants of other orders, including beets, cabbage, turnip, cucumber, celery and sweet potato. Sometimes they do injury to potatoes by gnawing the sprouts. Eggs are deposited in May or June, and the life cycle is very like that of the tobacco flea-beetle about to be described. Larvæ feed entirely under ground and transform to pupæ there.

TREATMENT.—The usual flea-beetle remedies are applicable. See page 65.

The Eggplant Flea-beetle (*Epitrix fuscula* Cr.).—The eggplant flea-beetle so nearly resembles the preceding that unless the two occur on the same plant they are apt to be confounded. It is of the same color, but considerably larger than the potato flea-beetle, and when closely examined it is at once seen that the impression at the base of the thorax is very feeble and that the wing-covers are more pubescent.

This species is most abundant on eggplant, but it is common on potato, horse nettle and similar wild plants. In Maryland, Virginia and the District of Columbia it is often difficult to find the foliage of eggplant that has not been very profusely punctured by the minute holes where the beetle has been feeding. Some little time after attack these holes become browner on the edges, and this portion at last dries, making the holes much larger and giving the plants a decidedly sickly appearance. It even attacks eggplant in frames. This species is obviously southern, not extending in the East, so far as known, north of New Jersey. It occurs in the Gulf region and in southern Ohio and Illinois, and in intermediate States southward.

REMEDIES.—The same as those employed against other flea-beetles.

The Tobacco Flea-beetle (*Epitrix parvula* Fab.).—This species is most important as an enemy of tobacco, and like

the preceding is commonest southward. Where occurring normally it is often found in about the same abundance on potato, eggplant, tomato, horse-nettle, night-shade and Jamestown weed. The plants mentioned are sometimes damaged and its work is evident on these crops from Maryland and Virginia southward.

The beetle is scarcely more than one-twentieth of an inch long, pale brown in color, the elytra being normally marked near the middle with a dark, transverse band of greater or less extent (fig. 140, *a*). The larva (*b*) is delicate, thread-like and white, except the head, which is yellow. The beetle riddles leaves in the same manner as do other flea-beetles, and in its attack on tobacco frequently renders plants unfit for use. It is doubtless a transmitter of certain diseases, which form about the punctures made by the beetle in obtaining its food supply. From experiments by the writer it has been learned that the full life cycle may be passed, in extremely hot weather, in 28 days. The egg period in such weather is about six days, the pupa is the same, which affords, by deduction, a larval period of 16 days.

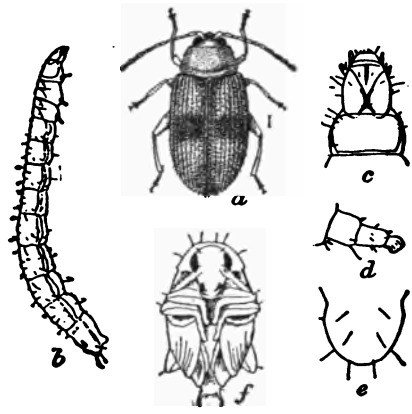

Fig. 140.—Tobacco flea-beetle, *a*, Beetle; *b*, larva; *c*, head of larva; *d*, posterior leg; *e*, anal segment; *f*, pupa. *a*, *b*, *f*, Enlarged about fifteen times; *c*, *d*, *e*, more enlarged. (Author's illustration, U. S. Dept. Agr.)

REMEDIES are discussed on page 65, on the flea-beetles.

The Black Blister Beetle (*Epicauta pennsylvanica* DeG.).—The farmer is quite too well acquainted with this and other blister beetles as unwelcome visitors to his potato patch, and florists know it as the "aster bug," from the severe injuries

which it does to asters and related plants. It is uniformly black, without polish, and its length varies from a little more than a quarter to half an inch. It is well distributed east of the Rocky Mountains, and does most injury between the Atlantic States and Texas. Its time of appearance is more or less coincident with the blossoming of the goldenrod, on which it is a familiar object, from June until October. As a rule it appears later than other species. It is one of the worst insect enemies of potato and beet, and is also destructive to carrots, beans, cabbage, corn, mustard, aster, clematis and other plants. For remedies see page 68.

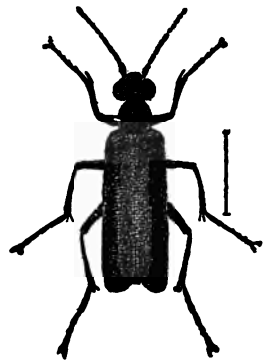

Fig. 141.—Black blister beetle. Enlarged. (Author's illustration, U. S. Dept. Agr.)

The Potato Stalk Weevil (*Trichobaris trinotata* Say.).—This is an important insect enemy of the potato, and a common species almost everywhere east of the Rocky Mountains and south of New England. Its larva works normally in the stems of horse nettle, ground cherry, and jimson weed, in most fields where these plants are allowed to grow.

The habit of this insect of attacking potato has been known since 1849. Since then injuries inflicted by it have attracted considerable attention, periodically and locally, and there is reason to believe that it is often present and doing damage, though undetected, in potato fields, where the insect itself has never been seen. Its habit of living in the stem in its larval condition, and the small size of the beetles, together with their trick of dropping from the plants when disturbed, is accountable for injury so often escaping notice.

The potato stalk weevil (fig. 142) is a small snout-beetle, about 1/6 inch in length. Its real color is black throughout,

but its surface is covered with minute gray scales, which give it a nearly uniform gray appearance. The head, however, is black, and there are three black impressed spots at the base of the wing-covers. The snout is robust and rather strongly curved. The northern limit of injurious occurrence of the potato stalk weevil is reached in Pennsylvania and New Jersey in the East, and in Illinois and Iowa in the West; recently, however, the species has been reported a pest in Canada. Southward the insect is found to Florida and Texas.

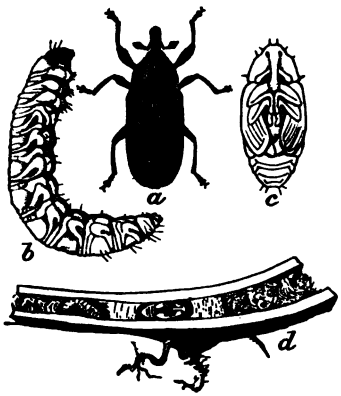

Fig. 142.—Potato stalk weevil. *a*, Beetle; *b*, larva; *c*, pupa; *d*, section of potato stalk opened to show larva and pupa *in situ*. *a*, *b*, *c*, Five times natural size; *d*, natural size. (Author's illustration, U. S. Dept. Agr.)

More often perhaps than not, injury by this pest is attributed to drought or blight. It is more conspicuous in seasons of prolonged drought and most severe on early varieties of potato. The undermining of the stalks by the larvæ causes them to wilt, and the wilting and the dying of the leaves is the first outward manifestation of attack. When the insects are present in the field it is often stated that the plants are "blighted." The diseases of potato are apt also to be mistaken for the work of the weevil, as in both cases the leaves look as if sunburned, especially after the vines have been affected for some time. Not infrequently a field suffers from the combined effects of dry weather, disease, and stalk weevil.

This insect attacks nearly all Solanaceæ growing within its natural range. The list includes, besides potato, eggplant, horse nettle, bull nettle, jimson weed, purple thorn apple, ground cherry and, it is said, cocklebur.

A single larva in a potato stalk is not sufficient to injure it to any extent, although it must have a weakening effect, but when many larvæ occur destruction is complete. As many as 5 or 6 individuals may sometimes be found in a potato stalk.

The beetles appear, in the vicinity of the District of Columbia, in the latter portion of May, and the female deposits her eggs singly in small slits about one-twelfth of an inch in length made in the stalks of the insect's food plants, and occasionally in the branches. In a week or ten days the larva hatches, and feeds by making small channels which increase in size with

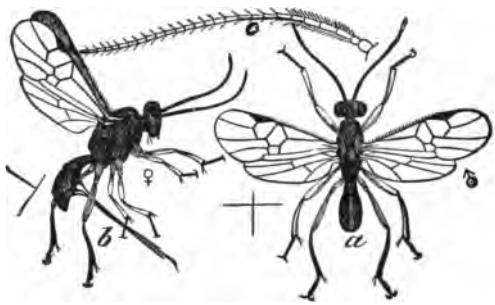

Fig. 143.—*Scalphus curculionis*. Parasite of potato stalk weevil. (After Riley)

the growth of the insect downward toward the bases of the stalks. The undermining of a stalk by the tunneling of several larvæ has the effect of impairing the vitality of the plant and causing the leaves to wilt and die. Upon attaining full growth the larva makes a cell of castings and woody fibers in which to transform. The beetles of the new generation appear as early as July 24. In northern localities development is slower, the beetles seldom appearing before August and maturing as late as September, and hibernation is always as a beetle. The knowledge of this fact is of value in the control of the species, as will be explained.

This weevil is subject to the attack of a small four-winged parasitic ichneumon fly, *Sigalphus curculionis* Fitch (fig. 143), a well-known enemy of the plum curculio, and sometimes it falls a prey to wireworms.

REMEDIES.—The best remedy is to pull infested vines as soon as they wilt and show evidence of attack, and spread them out so that they will be exposed to the sun and will dry and thus prevent the escape of the insects which they contain. All stalks in infested fields should be burned as soon as the crop is off. This will greatly lessen the number of weevils for the ensuing years. It is also advisable to keep down all solanaceous weeds. The time for their destruction is in July, after they have attracted the beetles for egg laying, or any time before the seeds are ripe. The use of fertilizers will often aid injured plants to recuperate from attack. Unfortunately, injury is not apt to be detected until the plants begin to die. As soon, therefore, as a plant shows weakness its stalk should be split open to ascertain the cause. Early potatoes are most subject to injury, and the latest varieties are practically exempt.

The Potato Tuber Worm (*Phthorimæa operculella* Zell.).—The tuber worm is probably the most injurious insect to the truck industry of California, where losses to the potato crop have been estimated as aggregating some years 25 per cent. In Salinas Valley, dealers claim that at times the loss has gone as high as 40,000 sacks a year. Potatoes from other sections have to be watched carefully to avoid "wormy" ones, as a very few such may infest a whole storeroom. As the potato is a product that is expected to retain its value for months, the possibility of destruction by insects while in store becomes a question of great seriousness, more particularly because rots follow the "worm," starting in its burrow and ultimately involving the entire tuber. Although the species is introduced and rather commonly distributed in temperate portions of the

United States, injury to potato is nearly confined to California, although tobacco is attacked in the South where the insect is known as the tobacco leaf-miner or split-worm. It is probable that this insect may in time become a pest in other regions, though not in the colder temperature States.

The moth (fig. 144) resembles a clothes-moth, but is darker. The wing expanse varies from 5/8 to about 7/8 of an inch. The fore-wings are mottled with dark brown and black, and the hind-wings are narrow, with long fringes. Eggs are deposited on the leaves, and the minute worms (*b, c*) hatching from them burrow into the stems and afterward into the potato tubers. Frequently early injury is done to plants in the field, but as the larvæ grow they work, later in the season, farther into the stems, and when these harden make their way to the tubers and finish their growth there. The potato is subject to infestation throughout the year, provided the tubers are stored in places that are not too cold for the insect's development. The life cycle, according to the studies of Mr. W. T. Clarke, may be accomplished in nine weeks, and in the winter, in the mild climate of California, this period is sometimes run in twelve weeks. When the larva is about six weeks of age it comes to the surface and transforms to pupa at the mouth of its burrow, or seeks a crack or depression in the potato when the tubers are stored. The usual course of the tuber worm is to mine beneath the outer skin of the plant, and molds and rots (bacterial and fungous growths) follow in its wake, the stalk

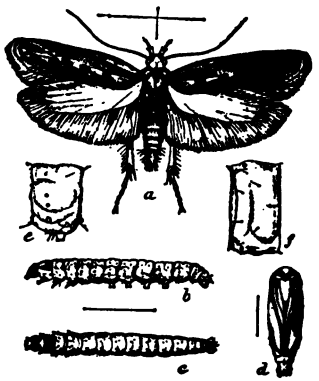

Fig. 144 —Potato tuber worm. *a*, Moth; *b*, *c*, larva or "worm"; *d*, pupa; *e*, *f*, abdominal segments of larva. *a-d*, Three times natural size; *e*, *f*, more enlarged. (Insect Life, U. S. Dept. Agr.)

finally succumbing to the combined injuries of insects and disease. Injury is three-fold to the plants above ground, and to the tubers in the field, and again in store. The moths oviposit on any part of a plant, on leaves, stems, on tubers in the hill and when exposed in the field and after they are stored.

METHODS OF CONTROL.—It is impossible to reach the tuber worms in their mines, in stalks or tubers growing in the field, therefore we must proceed against this pest in other ways. Several must be employed to insure success. First come clean methods of cultivation, which implies that all infested plants of potato and weeds of the vicinity must be destroyed, as such material affords a breeding place for the insect and its successful hibernation. Sheep and hogs can be utilized in the destruction of the remnants merely by turning them into the field. Crop rotation is desirable, and cooperation is practically a necessity. Where potatoes are extensively grown in a given region their cultivation might be discontinued for a year. Other plants than tomato, eggplant and tobacco would answer as alternates, and leguminous crops are particularly indicated, owing to their value as soil restorers. Careful compact hilling is an effective method in preventing infestation, especially to the tubers. Carelessness in digging, which consists in leaving potatoes in the field over night instead of promptly removing them to uninfested shelter, should be avoided.

The remedy that has been used with best results consists in placing infested potatoes in tight receptacles and treating them with bisulphid of carbon. Several treatments are sometimes necessary.

The Potato-scab Gnat (*Epidapus scabiei* Hopk.).—Some forms of potato-scab are due to the attacks of minute whitish maggots with blackheads which feed in decayed spots in tubers as well as upon healthy portions. The detection of these as the cause of scab is due to the investigations of Dr. A. D. Hopkins,[1]

[1] Special Bul. 2, West Virginia Agr. Exp. Station, 1895, pp. 97-111.

from whose publications the accompanying account has been compiled. The most destructive of these is known as the potato-scab gnat which, in its larval or maggot form, measures about one-sixth of an inch in length. It is the young of a wingless female and winged male gnat or midge, somewhat like the fickle midge treated in preceding pages as an enemy to cucumber. The female deposits eggs on tubers in the cellar from autumn to spring. The maggots enter old scab spots or slightly injured places, and under favorable conditions a generation is developed every 20 to 25 days. Later in spring the gnats deposit their eggs in manure or decomposing material, on seed

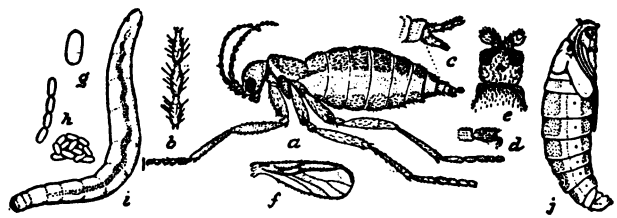

Fig. 145.—Potato scab-gnat. *a*, Fly; *i*, larva, *g*, egg; *h*, egg mass, etc. Much enlarged. (After Hopkins)

potatoes and growing tubers in the hill, to which they may be transferred on seed tubers or in decaying matter. Once within the tuber and the conditions remaining favorable, the potato is destroyed; but if the maggots are driven out by natural enemies or the soil becomes dry they disappear. The infested places show nearly the same characters as ordinary scab, for which malady it may be easily mistaken. The conditions most favorable to the increase of this pest are moist, damp cellars, and wet weather during the warmer season. They cannot thrive in dry soil or in perfectly dry storerooms. Immense loss to potatoes was caused in West Virginia during 1891 and 1892, in Philadelphia and probably in other sections of the country. Under favoring conditions for their increase, the gnats may be even

more destructive than the fungus, on account of their penetrating while in the larval stages deep into the substance of the tubers, thus rendering them worthless for market.

METHODS OF CONTROL.—Preventive measures that will at the same time be effective against the scab fungus apply quite as well to the gnats and their maggots. Dr. Hopkins recommends the following measures for protection against injury:

"Select sandy or other soils of a dry character in which a crop of surface growing vegetables or grain has been grown the previous year, and from which the refuse has been thoroughly removed in order that the soil may be as free from vegetable matter as possible. Do not use as fertilizers animal manures, lime, ashes, and like substances. If a fertilizer is necessary, use only a ground bone, phosphate, kainit and other commercial fertilizers of a like character. Select smooth and healthy tubers for seed. . . . When the potatoes are dug, and before they are stored, carefully sort out all tubers showing the least indication of decay, as well as those which are seriously affected with scab. Do not plant the same land in potatoes for at least three years after a potato crop is taken from it."

Soak seed potatoes in a solution of corrosive sublimate or formalin according to directions furnished in the chapter on insecticides. In case a piece of land is especially favorable for the production of potatoes of excellent quality, if the precaution is taken to remove and burn all rubbish, such as potato tops, weeds, refuse tubers, etc., the same land may be, by judicious fertilizing, planted in potatoes every alternate year.

CHAPTER XIV

INSECTS INJURIOUS TO THE TOMATO

In the introduction to the chapter on insects affecting potato, eggplant, and similar crops, it was stated that nearly all of these insects affect to a less extent the tomato. The species which will be here mentioned affect more particularly the tomato, and exceptionally potato and similar crops. The most important are the tomato or tobacco worms, the common stalk-borer, often so abundant on tomato as to be known as the tomato stalk-borer, which has previously been treated (page 199), and the tomato fruit worm, or the corn-ear worm. The aphides which infest potato, eggplant, etc., are likely to attack tomato and there are two additional species which have been observed on the latter.[1] Mealy-bugs, thrips, plant-bugs and other sucking insects also feed on it.

The Tomato Worms.—The large green "worms" that eat tomato leaves are well known. There are two distinct species of them, closely allied, much alike in all their stages, and practically indentical in habits. They are called indiscriminately tomato or tobacco worms and "hornblowers." In the District of Columbia and vicinity, the two species are of nearly equal occurrence as regards numbers on both tomato and tobacco. They are the larvæ of large sphinx moths.

The tomato worm (*Phlegethontius quinquemaculata* Haw.).—The tomato or northern tobacco worm is nearly as thick as one's little finger, and about three and a half inches long when extended. The horn is larger and less curved, and usually dark in color, whereas the Southern species has a shorter and

[1] *Rhopalosiphum solani* Thos. and *Nectarophora erigeronensis* Thos.

more curved red horn. On the sides of the body are eight longitudinal stripes which are met by a similar number of horizontal stripes, each segment forming an angle (fig. 146, *b*). The moth (*a*) which produces this tomato worm has a wing expanse of four inches or less. It is the paler form, and the bright orange spots on the sides of the abdomen are not so

Fig. 146.—Tomato worm. *a*, Moth: *b*, full-grown caterpillar; *c*, pupa. Half natural size. (After Howard, U. S. Dept. Agr.)

vivid as in the Southern species and only four in number, whereas the Southern form has five. The hind-wings are marked with zigzag lines more pronounced than in the Southern species. The dark mahogany brown pupæ of both are frequently turned out of the ground by the spade in early spring and later. They are the possessors of a handle-shaped process projecting from the head, that in the present species (fig. 146, *c*) being longer than in the Southern (fig. 148, *c*), indicative of the

longer or shorter proboscis of the moth of each. The pupæ measure about two inches in length.

The Northern species occurs throughout the United States and into Canada. It is also found on Jamestown weed, matrimony vine and ground cherry. The moths appear from May to June, according to locality and season, and as far north as New York City two generations are annually produced. The writer and others have noted two generations in Maryland and Virginia, while as far south as Florida, according to Quaintance, a third generation occurs. The moths deposit their eggs, usually singly, on the under surface of leaves. The eggs, according to Alwood's observations in Virginia, hatch in from four to eight days, and the caterpillars in the course of their growth cast their skins four times in less than a month. When full grown they burrow into the soil and transform to pupæ. Both "worms" are sometimes quite dark in color, but when they turn nearly black they are usually infected by a bacterial disease, which invariably kills them (fig. 147).

Fig. 147.—Southern tobacco worm dead and shriveled from bacterial disease. Natural size. (After Howard, U. S. Dept. Agr.)

Few observing persons have failed to see at sometime in their lives the caterpillars of these or other sphinx moths entirely covered with little white oval cocoons. These produce small four-winged parasites, and it is owing to the abundance of these and the bacterial disease that the insects are not more numerous than they are.

Remedies.—The amount of damage done by tomato worms will vary according to the vigilance of the grower. On small patches the "worms" are readily seen after a little experience,

and can be picked off by hand and destroyed, and if this is carefully done little apprehension may be experienced of damage. Clean culture and crop rotation are always to be practiced and the leaving of tobacco suckers, or abandoned remnants should be avoided, as the "worms" frequently remain in the field until the plants are killed by frost. It should be unnecessary to add that the worms may be killed by spraying with arsenicals. Turkeys are utilized in destroying these insects in the South.

The Southern tobacco worm (*Phlegethontius sexta* Joh.).—The differences of this species and the preceding have been pointed out. In brief, the moth (fig. 148, *a*) is darker, and the five orange spots on the body are larger and brighter. The "worm" has only seven oblique white lines on the sides, and

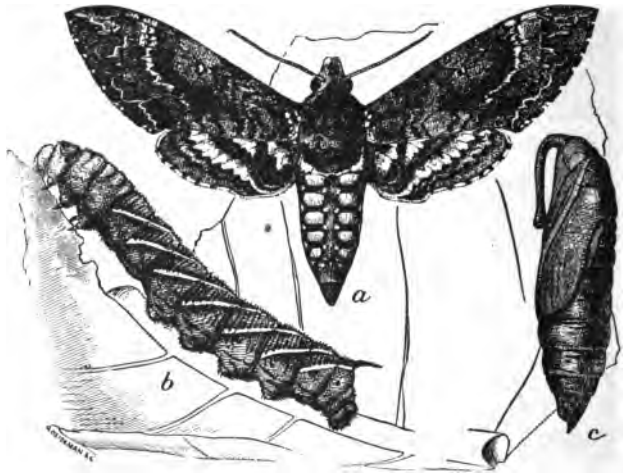

Fig. 148.—Southern tobacco worm. *a*, Moth; *b*, full-grown caterpillar; *c*, pupa. Half natural size. (After Howard, U. S. Dept. Agr.)

the tail is more curved and red. The pupa has a shorter proboscis. The Southern tobacco worm is distributed through the United States from the Atlantic to the Pacific, and from

Canada to the West Indies. No important differences between these two species have been noted as regards habits, time of appearance, susceptibility to diseases and to parasitic attack. In the writer's experience, the two species undergo their transformations throughout in about the same time.

REMEDIES are the same as for the tomato worm proper previously treated.

The Tomato Fruit Worm (*Heliothis obsoleta* Haw.).—This insect, as most modern farmers are aware, is the same species as the bollworm or corn-ear worm. It has been treated from

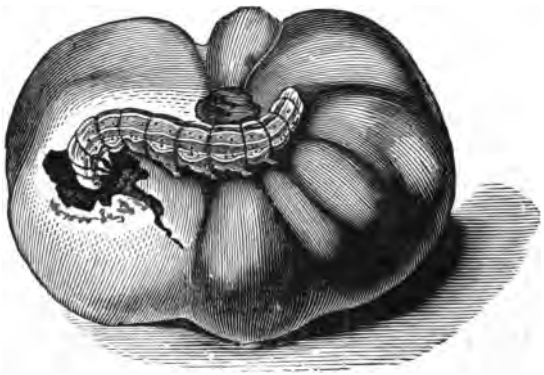

Fig. 149.—Tomato fruit worm boring in tomato. (After Riley)

the standpoint of a cotton pest in innumerable publications, and is considered among corn insects on page 207, but as yet we have discovered no direct remedy for it in its occurrence on tomato. It is frequently the cause of serious trouble to tomato growers over large areas, due to the "worms" eating into and destroying the green and ripening fruit.

REMEDIES.—For the protection of tomatoes, it is advisable not to plant in proximity to corn or cotton fields or on ground that has been grown the previous year to these crops or to beans or cowpeas, all of which are favorite host plants of this pest; nor should land be planted with tomatoes in infested

regions until it has been fall or winter plowed. Although no reports are available of satisfactory experiments having been performed in spraying for this species in its occurrence on tomato, it is possible that a spray of Paris green and Bordeaux mixture, or of either alone, might be satisfactory. It is therefore suggested that three out of four plats of equal size be treated *experimentally* in each of the manners described, the fourth plat to be left untreated, so that the effects can be noted. Spraying may be practiced up to about a week from the time of the fruit ripening without danger of poisoning human beings.

Miscellaneous Insects.—Of insects most to be feared when the plants are first set out are cutworms of various species. The tomato grower is well acquainted with these pests, and no description of their methods is necessary here, beyond the statement that they cut off and destroy more than they eat and resetting is frequently necessary. Cutworms are discussed more fully on pages 49 to 56.

Flea-beetles also attack the plants soon after they are set out. Their injuries can be prevented by dipping the young plants before setting in a solution of arsenate of lead, about 1 pound to 50 gallons of water, or Paris green, 1 pound to 100 gallons. See page 65 on flea-beetle remedies.

CHAPTER XV

INSECTS INFESTING THE SWEET POTATO

THE sweet potato is a staple from New Jersey and Maryland southward. It is seldom that plants are not more or less infested by insects, and of these the tortoise beetles are conspicuous because of the holes which they eat in the leaves. As the crop is started under glass and transplanted, it is subject to attack by cutworms and similar insects. There are several other defoliators, blister beetles, the larvæ of sawflies, a hawk-moth and others; flea-beetles sometimes do considerable injury, while in the extreme South the sweet-potato root-borer is becoming an important pest from its destruction of the tubers. In spite, however, of a considerable number of insects which attack this plant, it does not, on the whole, suffer very material injury save in restricted areas and in years when certain pests are abnormally abundant. The root-borer, however, threatens to be a permanent pest in the Gulf region.

The Sweet-potato Root-borer (*Cylas formicarius* Ol.).—Injury by this insect in North America was first noticed about 1877 near New Orleans, La., when it was claimed to threaten the destruction of the sweet potato crop of the country, a prediction which was, happily, not verified until about 1903.

The adult is a weevil of ant-like form except for the long snout which it possesses (fig. 150, *a*). It is small, about one-fourth of an inch in length, including the snout, the elytra are shining dark blue, the head and snout darker blue, and the thorax and long legs shining red. The larva (*b, c*) when grown is about one-fourth of an inch long, white, with brown head and darker mouth-parts.

This sweet-potato borer is of Oriental origin, and its native habitat is credited to Cochin China. It was probably introduced from the West Indies into Louisiana and Florida, and from the former States into Texas. The female deposits her eggs in the vines near the ground, and the larvæ after hatching tunnel through the tubers, and the vines die. Frequently tubers are so badly riddled and have such a bitter taste that neither fowls nor swine will eat them. The species is capable

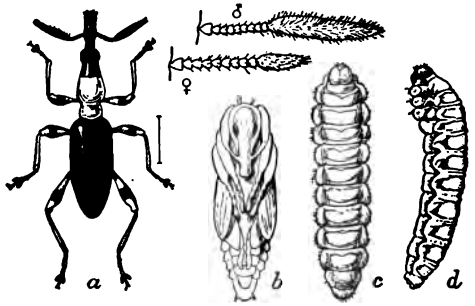

Fig. 150.—Sweet-potato root-borer. *a*. Male beetle; ♂, antenna of male, enlarged; ♀, antenna of female, enlarged; *b*, pupa; *c*, larva, dorsal view; *d*, larva, side view. All enlarged. (After Howard except *d*, original.)

of undergoing transformation from egg to adult in about 31 days and hence as many as four generations might be produced in a year. Considerable injury has been inflicted for a number of years in Louisiana and in Texas.

REMEDIES.—Care should be exercised not to transport tubers from infested localities to uninfested ones. If not too badly damaged the tubers may be disinfected with carbon bisulphid,[1] small tubers should be fed to hogs, and badly infested ones should be burned with the vines.

The Sweet-potato Tortoise Beetles (*Cassidini*).—In many sections, particularly where sweet potato is grown largely for market, this crop is attacked by tortoise beetles of which

[1] See Farmers' Bul. No. 145, U. S. Department Agriculture.

half a dozen species are common. They also affect morning-glory; it is seldom, in fact, that the latter plants are free from their attacks. The most common form of injury is manifested by numerous more or less rounded holes eaten in the leaves, and this, if traced to its source, will usually be found to be due to the presence of the tortoise beetles. Some of these insects are truly wonderful. The golden tortoise beetle, known as "the gold bug," is one of the most beautiful creatures imaginable when it is resting at ease or feeding in daylight. At this time it has the appearance of a globule of burnished gold. If the beetle is disturbed this golden color disappears, and it fades also toward sundown and does not remain after death in dried specimens. The larvæ which produce these beetles are also remarkable because of their singular habits. They are the

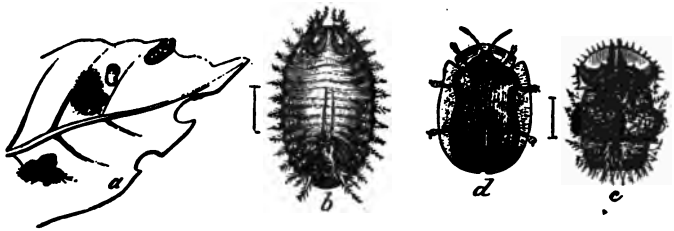

Fig. 151.—Golden tortoise beetle. *a*, Larvæ working on leaf; *b*, larva divested of "pack"; *c*, pupa; *d*, beetle. *a*, Natural size; *b*, *c*, *d*, enlarged. (After Riley)

possessors of peculiar forked appendages which serve as receptacles for their cast-off skins and for their excrement as it is voided. When divested of the cast larval skins and excrement, the larvæ are seen to be flat below, like the beetles, and convex above, the margins projecting into peculiar-shaped spines. These larvæ are sometimes termed "pedlars," the fork with its load being designated as the pack. Beetles, as well as larvæ, feed chiefly on the under surfaces when not exposed to direct sunlight. Injury is mainly to young plants, the beetles making their first appearance at about the time plants are reset. Soon after appearing the females begin laying eggs, and in about

a week or a few days longer the larvæ hatch and assist the beetles in their work of destruction. Indications are that all of these tortoise beetles are single-brooded, hibernation taking place in the adult stage.

The Golden Tortoise Beetle (*Coptocycla bicolor* Fab.) is the most striking of the tortoise beetles, and well known and destructive. In this form (fig. 151) the entire body is golden with exception of the borders; that is, when the insect is resting on leaves exposed to the sun. If a specimen be captured the colors fade to a dull, deep orange, sometimes with a few golden spots remaining, and two black spots are noticed near the middle of the insect. The size varies from two-twelfths to three-twelfths of an inch. The larva (*b*) carries its "pack" directly over the back, and the excrement is arranged in a more or less regular three-lobed pattern.

Fig. 152.—Golden tortoise beetle egg. Much enlarged. (After Riley.)

The Mottled Tortoise Beetle (*Coptocycla guttata* Ol.).—This species is about equally as common and of the same size as the golden tortoise beetle. It is shown in its various stages in figure 153. It differs in having the elytral ground color

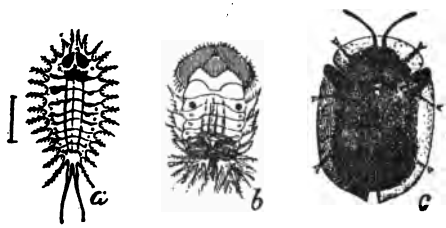

Fig 153.—Mottled tortoise beetle. *a*, larva; *b*, pupa; *c*, beetle. (After Riley)

black, extending at the shoulders on each side. Sometimes it is flecked with gold and at other times with yellow. The larva (*a*) is green, with a bluish shade down the back. It carries its excrement and cast skins in irregular broad masses, fre-

quently branching as in some other species. Before changing to pupa it removes the fæces from its fork. The pupa (*b*) is also green, with a black ring around the base of the first abdominal pair of spiracles.

The Two-striped Sweet-potato Beetle (*Cassida bivittata* Say.).—In 1869 this was stated to be the most common of the tortoise beetles occurring on sweet potato seeming to be confined to that

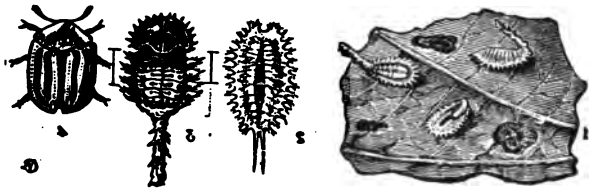

Fig. 154.—Two-striped sweet-potato beetle. *1*, Larvæ at work on leaves; *2*, larva; *3* pupa; *4*, beetle. *1*. Natural size; *2*, *3*, *4*, enlarged. (From Riley)

plant. From the District of Columbia northward, where the writer has observed it, it is much less abundant than the two preceding, hence it is of less importance economically. The beetle (fig. 154, *4*) is yellow and has two black stripes on the elytra, whence the common name. The larva (*2*) is dirty whitish or yellowish, showing a rather indistinct line along the back. From similar larvæ on sweet potato it can be known from the fact that it does not use its fork for carrying excrement, but only as a repository for cast skins. This fork is usually elevated at an angle of about 45°, which suggests the idea of a handle.

Fig. 155.—Black-legged tortoise beetle. (After Riley.)

The Black-legged Tortoise Beetle (*Cassida nigripes* Ol.).—From other sweet-potato tortoise beetles this species (figs. 155, 156) may be distinguished by its larger size. It measures nearly one-third of an inch. Like the golden tortoise beetle, it is reddish except when in bright sunshine, and has the same power of assuming a golden hue, apparently at will. Its

distribution extends from ocean to ocean, and it is apparently more abundant on the Pacific coast than eastward.

REMEDIES.—The tortoise beetles which prey upon sweet

Fig. 156.—Black-legged tortoise beetle. *a*, Larvæ, natural size; *b*, larva divested of pack of excrement; *c*, pupa. Both enlarged. (After Riley)

potato are not as a rule of great economic importance. The remedies prescribed below for the sweet-potato flea-beetle are about all that are usually required.

The Sweet-potato Flea-beetle (*Chætocnema confinis* Lec.).—In parts of the United States, notably in New Jersey and Maryland, this insect causes considerable injury to the sweet potato by eating out channels along the veins on both surfaces of the leaves soon after the plants are set out. This gives the leaves the appearance of having been attacked by a leaf-miner. Soon after attack on young plants, the entire surface becomes seared. When the insect occurs in numbers leaves are destroyed and plants are killed outright. Attack is most severe on ground previously grown in sweet potato, and also follows the clearing of fields which have been allowed to grow in bindweed, one of the insect's natural food plants.

REMEDY.—Plants before setting out should be dipped in a strong solution of arsenate of lead, and one or two sprayings of the leaves with arsenicals a week or two later is about all that is needed, because the plants, being hardy, easily recuperate from attack and suffer little injury other than that of defolia-

tion. The first application is to accomplish the destruction of the beetles before they deposit their eggs, and the second and third are to kill beetles that may come from other plants. Rotation of crops and the avoidance of planting in the vicinity of neglected ground that has grown up with bindweed and wild morning-glory are also advisable.

The Common Sweet-potato Sawfly (*Schizocerus ebenus* Nort.).—The larvæ of two species of sawflies have been observed doing injury to sweet potato. They are comparatively new as pests and of similar habits and distribution from New York to the Gulf and northward to Nebraska.

Fig. 157.—*Eubadizon schizoceri.* Parasite of sweet-potato sawfly. (After Insect Life)

The present is like other sawflies, four-winged, and somewhat smaller than a house fly, the body is black, and the wings infuscated or dusky. The male has forked antennæ while the female has shorter simple ones. Eggs are deposited in the leaf of sweet potato. Attack has been observed in August and September in Mississippi, and a parasite (fig. 157) has been reared from the larva. This parasite, and a tachina fly, which also preys on it, no doubt hold the insect in check and prevent serious injury.

The Larger Sweet-potato Sawfly (*Schizocerus privatus* Nort.).—The first record that we have of injury by the larvæ of this sawfly was in July, 1890, when it damaged sweet potato in Virginia. At that time plants that were attacked produced no yield whatever. This sawfly is larger than the preceding, the wing expanse being nearly 3/5 of an inch, and both sexes have yellow abdomens. Other differences can be made out by

comparison of the illustration of each. According to Marlatt, deposition of the eggs is on the under surface of the leaf, and by reference to figure 158, *a*, it will be seen that eggs are placed usually in parallel rows bordering the larger veins of

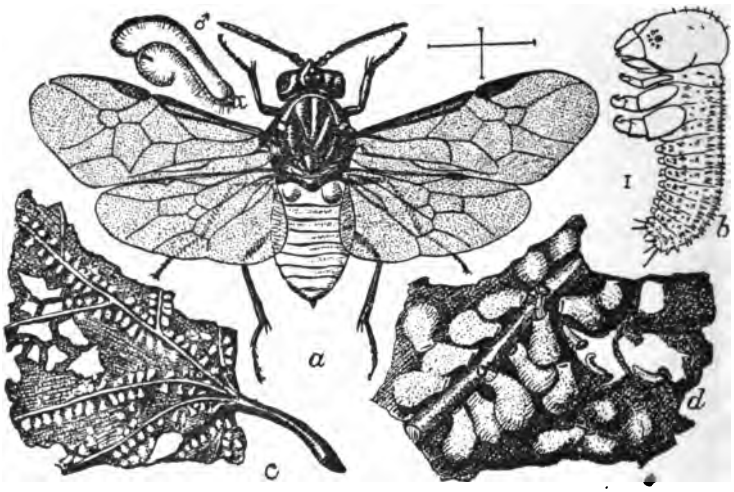

Fig. 158.—Larger sweet-potato sawfly. *a*, Female sawfly· ♂ . antenna of male; *b* young larva; *c*, section of infested sweet-potato leaf. showing egg deposit· *d* same showing larva hatching and feeding. *a*, *b*, *d*, ♂ , Enlarged; *c*, natural size. (Adapted from Marlatt.)

the leaf. Larvæ are seen hatching from the pouch-like egg receptacles or blisters at *b*.

Remedies.—Both these sawfly larvæ when abundant may be easily controlled by the prompt application of hellebore or arsenicals when they make their first appearance.

Cutworms.—Since sweet potato is cultivated in seed-beds, it is subject to the ravages of cutworms when set out in newly-plowed fields. One of these, the dark-sided cutworm (*Carneades messoria* Harr.), appears to be particularly identified with attack of this nature. It is a common species, and in addition to various garden crops seems to revel in onions. A

more complete account, with illustrations, has been furnished on page 246. The variegated cutworm, in years when it indulges in uprisings, also injures sweet potato and some other cutworms and other caterpillars of less importance occasionally cause losses to this plant.

REMEDIES for these insects are duly treated on page 54.

Mealy-bugs (*Dactylopius* spp.).—A species of unidentified mealy-bug has been mentioned by Dr. J. B. Smith as destructive in Salem County, N. J., in 1901, to sweet-potato in forcing beds.[1] They were found clustered at the bases of the sprouts and of the small leaves. It is not probable that these insects would survive normal outdoor conditions when plants are set out in spring in New Jersey, but in the Gulf region they doubtless would develop out-of-doors quite as well as under glass. For protection against mealy-bugs cellars and storerooms should be thoroughly whitewashed and cleaned before the seed tubers are stored and the temperature should be kept low while in the beds where the roots are forced in spring. Cleanliness should be observed and the roots should be inspected before putting them in, and such as show the mealy-bugs should be rejected and destroyed.

[1] Rept. Dept. Ent. N. J. Agr. Coll. Exper. Sta. for 1901 (1902), p. 489.

CHAPTER XVI

INSECTS INJURIOUS TO MISCELLANEOUS VEGETABLE CROPS

THE ONION AND OTHER BULB CROPS

BULB crops are so similar that what will attack one is apt to feed on the others. Six crop plants (genus Allium) are included in this group: the common onion, Welsh onion, shallot, cive, leek and garlic. Of these only the first is grown to any extent in North America. "The onion," some one has remarked, "is one of those strenuous vegetables about which one cannot be indifferent. One either yearns for it with a passionate longing or else utterly repudiates it." The same is true as regards insects, since few species are overfond of it. The leading species are the onion maggot and onion thrips. A few insects of omnivorous tendencies, however, not infrequently do much injury to this plant. Of such are some forms of cutworms, and especially the dark-sided cutworm, wireworm, and the imbricated snout-beetle. The pungent odor of the onion and its kind renders it unpalatable to many insects, but some resort to these plants in the absence of other vegetation.

Insect injury to onion and related plants is peculiarly local or intermittent, and in spite of the injurious species which will be treated, and the immense amount of damage that they have done, it is no uncommon sight, but in fact the rule, to see fields grown to these crops year after year for long periods without their sustaining any material harm. Such is the case about the District of Columbia, where no insects what-

ever have been noticed in recent years injuriously affecting the onion crop.

The Imported Onion Maggot (*Pegomya cepetorum* Meade).—This maggot injures the onion by eating into the bulbs, the subsequent decay of the affected portions frequently destroying them. It is a most important drawback to the culture of onions here and in Europe, from which continent it was introduced years ago. It is nearly related to the seed-corn, and cabbage, maggots treated in former pages. In the adult state it resembles, as do the others, the common house fly. The average size is a little larger than the flies of the two root-maggots that have been mentioned, the body being about 3/16-inch long and the wing expanse nearly 3/8-inch. The maggot itself and the puparium can be distinguished from those of other root-maggots only by careful comparison.

The life history is very like that of the cabbage maggot, the differences being due to the different character of the vegetables attacked. It follows that the natural enemies which prey on one are liable to attack the others, and the remedial measures to be adopted are also much the same.

REMEDIES.—For a discussion of remedies the reader is referred to the account of the seed-corn maggot.

The Black Onion Fly (*Tritoxa flexa* Wied.).—This is an old enemy of onion and a native species, recorded from the Atlantic coast to Illinois. The fly is about one-third of an inch long, black, with three oblique white stripes on each wing. The maggot itself is white and larger than the root-feeding species previously treated. It feeds on onions and cives both in the field and in store. General remedies are the same as for the

Fig. 159.—Black onion fly. Three times natural size. (After Walsh)

seed-corn maggot (page 108). In addition bisulphid of carbon is desirable for the treatment of stored onions.

Cutworms (*Euxoa messoria, etc.*)—Onions, as has been stated, are not particularly favored by many insects of omnivorous tendencies, but the variegated cutworm is quite destructive to it and there is one other species, the dark-sided cutworm, which might well be called the onion cutworm, from the great injuries which it causes to this crop. In 1885, near Goshen, New York, this cutworm (shown in figure 160) threatened the extinction of the onion industry, the annual value of which was estimated at half a million dollars. Although the people worked day and night to keep down the pest, the yield was reduced during that and the following year about one-half, or a total cash loss of about $500,000.

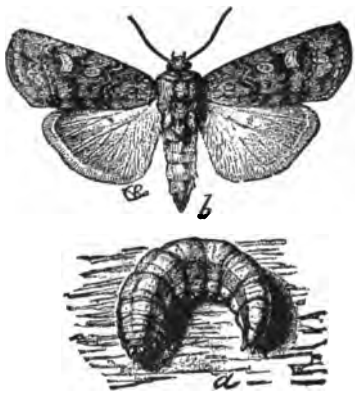

Fig. 160.—Dark-sided cutworm (*Euxoa messoria*). *a*, Cutworm; *b*, moth. (After Riley)

REMEDIES.—This species can be treated in the usual manner for cutworms.

The Onion Thrips.—For an account of the onion thrips see page 89.

RHUBARB

Rhubarb or pie-plant is rather unusually exempt from injurious attack by insects, a fact which is largely to be accounted for by the rapid and early growth of this plant, its vigor, and large stalks and leaves. No natural enemies appear to have been introduced with it, and it generally attains full market growth before the appearance of most insects which might

injure it. Several species attack rhubarb, but only two or three appear to prefer it to other plants cultivated in this country. Two insects that are specially identified with rhubarb are the rhubarb curculio and the rhubarb flea-beetle. It is also quite subject to the attack of aphides.

The other insects which infest this plant are general feeders, such as cutworms and some other caterpillars and a few leaf-feeding beetles.

The Rhubarb Curculio (*Lixus concavus* Say.).—Injury by the above-mentioned species is accomplished by the beetles puncturing the stalks for food, although occasionally they attack the leaves and seed stalks. This causes the plant to exude juice copiously which, drying, forms clear, tear-like drops (fig. 161). Eggs are often deposited in the stems, but the leaves do not develop, doubtless owing to the moisture caused by the beetles' punctures. The larvæ breed exclusively in weeds, such as dock (Rumex), and occasionally in sunflower (Helianthus).

Fig. 161.—Section of rhubarb stalk showing injury by rhubarb curculio. (Author, U. S. Dept. Agr.)

The insect under discussion is a large, rusty-coated curculio or snout-beetle, measuring from the tip of its long proboscis about three-fourths of an inch, and being of the form shown in figure 162, *a*.

Remedies.—The use of poisons on rhubarb during its growing season is out of the question, but the beetles are so conspicuous that they can readily be seen on the leaves, and as they are sluggish there is no difficulty in capturing them. They should

be gathered also upon nearby plants of dock, and after the eggs have been deposited on the dock stems these plants should be pulled up and burned before the development of the adults.

The Rhubarb Flea-beetle (*Psylliodes punctulata* Mels.).—This species shows a great preference for rhubarb where obtainable over other vegetables, among which are cucumber, radish, and beet. It is dark, brassy green, and finely punctulated, with its femora, tarsi, and the basal joints of antennæ pale,

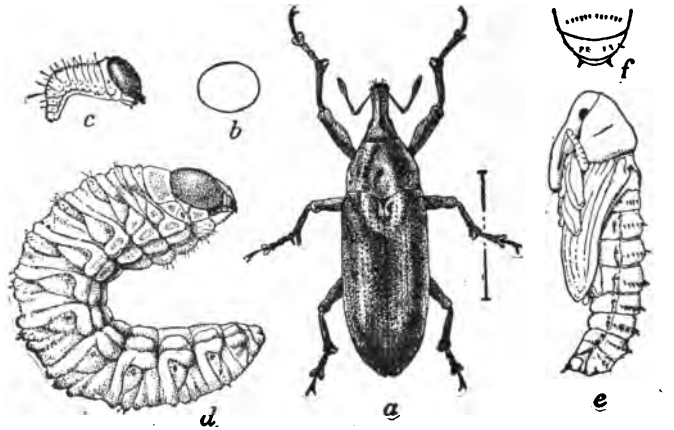

Fig. 162.—Rhubarb curculio. *a*, Beetle; *b*, egg; *c*, newly-hatched larva; *d*, full-grown larva; *e*, pupa; *f*, dorsal view of last abdominal segments of pupa. All about twice natural size. (Author's illustration, U. S. Dept. Agr.)

obscure yellowish. Both the upper and lower surface of leaves are affected by the beetle gnawing through and devouring the pulp, leaving the skin on the opposite side entire, which becomes discolored, forming yellowish brown freckles as the leaf grows and expands, the skin at these points becoming in time torn and showing holes. When the beetles occur in numbers leaves are sometimes riddled by these punctures.

REMEDIES.—Ordinary flea-beetle remedies are recommended. (See page 65.)

LETTUCE

Of minor truck plants, which will be considered in this chapter, lettuce appears, on account of its tender leaves and lack of decided flavor, the most favored by insects. It does not seem to have any insects specially attached to it, but there is one species, the lettuce earth-louse, which may fall in this category. At least a score of species are known to affect it occasionally. Among the most troublesome of these are the common cabbage looper and celery worm, treated in the consideration of insects which affect cabbage and celery respectively. Cutworms are not partial to lettuce, but some species, particularly the variegated cutworm, attack it; a species of thousand-legged worm has been recorded as being very destructive by attacking the outside leaves near the main stalk and four species of aphides or plant-lice are recorded as feeding on lettuce.

The Lettuce Earth-louse (*Rhizobius lactucæ* Fitch).—This common eastern species occurs sometimes in destructive numbers at the roots of lettuce. It is oval, dull whitish, with dusky legs and antennæ, and measures less than one-tenth of an inch. The entire body is coated as though dusted with a whitish powder. It should be treated in the same manner as the root-aphides to which group it belongs.

OKRA OR GUMBO

The insect enemies of okra are practically the same as of cotton, which belongs to the same botanical family. Okra, however, is little damaged, and the writer has for several years seen plantings that were not seemingly at all injured by the few insects which were present. One of the principal enemies of okra is the melon aphis, which sometimes occurs upon it in great numbers. The bollworm enters the pods, but evinces no special fondness for them. Several leafhoppers are found on okra, and of these is the waved sharpshooter (*Oncometopia*

[*Proconia*] *undata* Fab.). The foliage at times shows holes where such general feeders as the twelve-spotted cucumber beetle have attacked it, apparently in wantonness, while the plants were still young.

SALSIFY

The insect enemies of salsify, or vegetable oyster, were under observation by Mr. F. M. Webster some years ago.[1] He records the occurrence of two common species of leaf-rollers and three aphides on the plant, the yellow bear, or caterpillar of the ermine moth, and the tarnished plant-bug. There are other species which attack it, all general feeders, but there appear to be few, if any, records of injurious occurrences.

PEPPER

Peppers were grown in the United States until 1904 without serious attack by insects being recorded. That year a little pest known as the pepper weevil (*Anthonomus eugenii* Cano) attracted attention by its injuries to peppers of all varieties at Boerne, Texas. This species (fig. 163) is a relative of the notorious Mexican cotton-boll weevil and has the same origin and a similar life history. It is a native of Mexico from which country it has been introduced into Texas.

Fig. 163.—Pepper weevil. Greatly magnified. (Hunter & Hinds, U. S. Dept. Agr.)

REMEDIES.—Gathering and destroying the fallen pepper pods in which the larva feeds and the beetle develops or burying the infested pods by bedding high and lowering the soil are suggested as methods of control. Where pepper is grown in irrigated land this practice serves to check the insects, as the

[1] See list, Insect Life, Vol. II., page 259.

decay of the pods is hastened and the larvæ are thus deprived of a food supply.[1]

Some of the potato and tomato pests considered in earlier pages occasionally infest peppers, but do not as a rule do noticeable injury. Among these are the tomato worms, bollworm, white fly, and Colorado potato beetle.

[1] This species is treated under the name of *Anthonomus æneotinctus* Champ. in Bul. 54, Bur. Ent., U. S. Dept. Agr., pp. 43–48, and Bul. 63, pp. 55–58, by C. M. Walker and F. C. Pratt respectively.

CHAPTER XVII

BIBLIOGRAPHY

A short list of some of the more important and readily available publications on economic entomology in which the insects injurious to vegetable crops are treated follows. In compiling such a list some precedence is given to the publications of the Federal Department of Agriculture because as a rule they have a wider scope than State Agricultural Experiment Station publications, are printed in larger editions and are accessible to all, being for the most part free on application. Many of these contain bibliographical references. The list begins with works on general and economic entomology.

WORKS ON GENERAL AND ECONOMIC ENTOMOLOGY

1841. HARRIS, T. W.—Insects Injurious to Vegetation. Flint ed., 1851. Orange Judd Co., New York. First ed., Cambridge, 1841.

1855. FITCH, ASA—Reports of the State Entomologist of New York. I.–XIV., Albany, 1855–1870. (See Lintner's First Annual Report, State Ent. New York, pp. 294–297.)

1865. THE PRACTICAL ENTOMOLOGIST. Vols. I. and II. Published by the Entomological Society of Philadelphia, 1865–1867.

1868. THE AMERICAN ENTOMOLOGIST, edited by B. D. WALSH and C. V. RILEY. Vols. I.–III., 1868–1880.

1869. RILEY, C. V.—Reports of the State Entomologist of Missouri. I.–IX. Jefferson City, 1869–1877.

1879. Reports of the Entomologists of the U. S. Department of Agriculture. J. H. COMSTOCK (1879–1880); C. V. RILEY (1878–1879, 1880–1894). L. O. HOWARD (1894 to date).

1882. LINTNER, J. A.—Reports of the State Entomologist of New York, I.–XIV. Albany, 1882–'97.

1882. TREAT, MARY—Injurious Insects of the Farm and Garden. Orange Judd Co., 1882. (A small work compiled from RILEY's reports.)

1883. FORBES, S. A.—Reports of the State Entomologist of Illinois, I.–XXIII. 1883–1905.

1891. WEED, C. M.—Insects and Insecticides. 281 pp., 143 figs. Hanover, N. H., 1891.

1895. COMSTOCK, J. H. and ANNA B.—A Manual for the Study of Insects. 701 pp., 797 figs. Ithaca, N. Y.

1896. SMITH, J. B.—Economic Entomology. 481 pp., 483 figs. Philadelphia, 1896.
1902. JOHNSON, W. G.—Fumigation Methods. Orange Judd Co., New York. 313 pp., 83 figs.
1902. SANDERSON, E. D.—Insects Injurious to Staple Crops. New York. 295 pp., 162 figs.

Bulletins of the Division and Bureau of Entomology of the U. S. Department of Agriculture, I–XXXIII., o. s., 1883–1895, 1–71, n. s., 1896–1907. (Buls. 19, 23, 29, 33 and 43 treat of insects injurious to vegetables.) Insect Life, vols. I.–VII., 1888–1897.

Circulars, Division and Bureau Ent. U. S. Dept. Agr., 1891–1907. (Circ's. 10, 16, 31, 38, 39, 43, 57, 59, 60, 62, 63, 65, 80 and 87 treat of insects which affect vegetable crops.)

The publications of the various state agricultural experiment stations may be obtained by residents of the States where these documents are issued.

GENERAL CROP PESTS

Cutworms. SMITH—Bul. 109, New Jersey Agr. Exp. Sta., pp. 3–13, figs. 1–3, 1895; SLINGERLAND—Bul. 104, Cornell Univ. Agr. Exp. Sta., pp. 553–600, figs., 1895.

Spotted Cutworm (*Noctua c-nigrum* Linn). CHITTENDEN—Bul. 27, n. s., Div. Ent. U. S. Dept. Agr., pp. 54–58, 1901.

Variegated Cutworm (*Peridroma saucia* Hbn. [*Agrotis saucia*]). CHITTENDEN—Bul. 29, n. s., Div. Ent. U. S. Dept. Agr., pp. 46–64, 1901 (includes bibliography).

Black Cutworm (*Agrotis ypsilon* Rott.). RILEY—Rept. U. S. Dept. Agr. f. 1884, pp. 294, 295, 1885.

Army Worm (*Heliophila unipuncta* Haw. [*Leucania unipuncta*]). HOWARD—Circ. 4, Div. Ent. U. S. Dept. Agr., 1894; SLINGERLAND—Bul. 133, Cornell Univ. Agr. Exp. Sta., pp. 233–258, 1897.

Fall Army Worm or Grass Worm (*Laphygma frugiperda* S. & A.). CHITTENDEN—Bul. 29, n. s., Div. Ent. U. S. Dept. Agr., pp. 13–45, 1901 (Bibliography).

Wireworms. COMSTOCK and SLINGERLAND—Bul. 33, Cornell Univ. Agr. Exp. Sta., pp. 193–272, figs., 1891; SLINGERLAND—Bul. 107, Cornell Univ. Agr. Exp. Sta., pp. 37–56, 1896; FORBES—18th Rept. St. Ent. Ills., pp. 27–51, 1894.

White Grubs. FORBES, S. A.—18th Rept. St. Ent. Ills., pp. 109–145, 1894; Bul. 44, Univ. Ills. Agr. Exp. Sta., pp. 257–281, 1896; CHITTENDEN—Bul. 19, n. s., Div. Ent. U. S. Dept. Agr., pp. 67–80, 1899.

Grasshoppers or Locusts. RILEY—Bul. 25, o. s., Div. Ent. U. S. Dept. Agr., pp. 1–62, figs. and pls., 1891. (Compiled from 1st and 2nd Repts. U. S. Ent. Comm., etc.)

Pale-striped Flea-beetle (*Systena blanda* Mels. [*S. tæniata* Say]). CHITTENDEN—Bul. 23, Div. Ent. U. S. Dept. Agr., pp. 23–30, 1900.

Red Spider (*Tetranychus bimaculatus* Haw. [*T. telarius* Authors]). CHITTENDEN—Bul. 27, n. s., Div. Ent., U. S. Dept. Agr., pp. 35–42, 1901.

ASPARAGUS

General. CHITTENDEN—Bul. 10, n. s., Div. Ent. U. S. Dept. Agr., pp. 54–62, 1898.

Common Asparagus Beetle (*Crioceris asparagi* L.). CHITTENDEN—Ybk. U. S. Dept. Agr. f. 1896 (1897), pp. 341–349; Bul. 66, Bu. Ent., pp. 6–9, 1907

Twelve-spotted Asparagus Beetle (*Crioceris 12-punctata* Ol.). CHITTENDEN—Ybk. U. S. Dept. Agr. f. 1896 (1897), pp. 349–352; Bul. 66, Bu. Ent., pp. 9, 10, 1907.

Asparagus Miner (*Agromyza simplex* Loew.). L. c., pp. 1–5, figs. 1 and 2, 1907.

BEANS AND PEAS

General. CHITTENDEN—Ybk. U. S. Dept. Agr. 1898 (1899), pp. 233–280, figs.

Bean Leaf-beetle (*Cerotoma trifurcata* Forst. [*C. caminea* Fab.]). CHITTENDEN—Bul. 23, n. s., Div. Ent. U. S. Dept. Agr., pp. 30, 31, 1900.

Pea Aphis (*Nectarophora destructor* Johns. [*Nectarophora pisi*]). CHITTENDEN—Bul. 23, n. s., Div. Ent., U. S. Dept. Agr., pp. 33–37, fig. 9, 1900.

Bean Leaf-roller (*Eudamus proteus* Linn.). CHITTENDEN—Bul. 33, n. s., Div. Ent. U. S. Dept. Agr., pp. 92–96, fig. 20, 1902.

Lima-bean Stem-borer (*Monoptilota nubilella* Hulst.). CHITTENDEN—Bul. 23, n. s., Div. Ent. U. S. Dept. Agr., pp. 9–17, 1900.

Smaller Corn Stalk-borer (*Elasmopalpus lignosellus* Zell.). CHITTENDEN—Bul. 23, n. s., Div. Ent. U. S. Dept. Agr., pp. 17–22, 1900.

BEETS AND SPINACH

General. FORBES and HART—Bul 60, Ills. Agr. Exp. Sta., pp. 397–532, figs. 97, pls. I.–IX., 1900. (A monographic account with bibliography); CHITTENDEN—Bul. 43, Div. Ent. U. S. Dept. Agr., pp. 1–71, figs., 1903. (Short accounts of principal insect enemies.)

Leaf-miner (*Pĕgomya vicina* Lint.). SIRRINE—14th Annual Rept. Board of Control, N. Y. Agr. Exp. Sta., pp. 625–633, Pl. IV., 1896.

Larger Beet Leaf-beetle (*Monoxia puncticollis* Say. [*Galeruca maritima*]). CHITTENDEN—Bul. 18, n. s., Div. Ent. U. S. Dept. Agr., p. 95, 1898.

Beet Aphis (*Pemphigus betæ* Doane). DOANE—Bul. 42, Wash. State Agr. Exp. Sta., 14 pp., 4 figs., 1900.

Beet Army Worm (*Laphygma exigua* Hbn.). CHITTENDEN—Bul. 33, n. s., Div. Ent. U. S. Dept. Agr., pp. 37–46, fig., 1902.

Beet Webworm (*Loxostege sticticalis* Guen.). GILLETTE—13th Ann. Rept. Colo. Agr. Exp. Sta., pp. 128–130, 1900 (1901); Bul. 98, Agr. Exp. Sta. Colo., pp. 3–12, pls. I. and II., 1905.

CABBAGE AND OTHER COLE CROPS

Cabbage Maggot (*Pegomya* [*Phorbia*] *brassicæ* Bouché). CHITTENDEN—Circ. 63, Bu. Ent., U. S. Dept. Agr., pp. 3–6, figs., 1906; SLINGERLAND—Bul. 78, Cornell Univ. Agr. Exp. Sta., pp. 481–577, 1894; SMITH—Bul. 200, N. J. Agr. Exp. Sta., pp. 1–27, 13 figs., 1907.

Imported Cabbage Worm (*Pontia rapæ* Linn.). CHITTENDEN—Circ. 60, Bu. Ent., U. S. Dept. Agr., 8 pp., 6 figs., April, 1905.

Cross-striped Cabbage Worm (*Evergestis* [*Pionea*] *rimosalis* Guen.). CHITTENDEN—Bul. 33, n. s., Div. Ent., U. S. Dept. Agr., pp. 54–59, 1902.

Cabbage Looper (*Autographa brassicæ* Riley [*Plusia brassicæ*]). CHITTENDEN—Bul. 33, n. s., Div. Ent., U. S. Dept. Agr., pp. 60–69, 1902.

Imported Cabbage Webworm (*Hellula undalis* Fab.). CHITTENDEN—Bul. 19, n. s., Div. Ent., U. S. Dept. Agr., pp. 51–57, 1899.

CUCUMBER, MELON AND RELATED PLANTS

General. QUAINTANCE—Bul. 45, Ga. Agr. Exp. Sta., pp. 25–50, figs., 1899; SMITH—Bul. 94, N. J. Agr. Coll. Exp. Sta., pp. 3–40, 1893.

Striped Cucumber Beetle (*Diabrotica vittata* Fab.). CHITTENDEN—Bul. 19, n. s., Div. Ent. U. S. Dept. Agr., pp. 48–51, 1899; Circ. 31, Div. Ent. U. S. Dept. Agr., 1898.

Twelve-spotted Cucumber Beetle (*Diabrotica duodecimpunctata* Oliv.). See Corn root-worms.

Squash Ladybird (*Epilachna borealis* Fab.). CHITTENDEN—Bul. 19, n. s., Div. Ent. U. S. Dept. Agr., pp. 11–20, 1899. (Includes bibliography).

Melon Aphis (*Aphis gossypii* Glov. [*Aphis cucumeris* Forbes]). CHITTENDEN—Circ. 80, Bu. Ent. U. S. Dept. Agr., 16 pp., 6 figs., 1906.

Squash Bug (*Anasa tristis* DeG.). CHITTENDEN—Circ. 39, Div. Ent. U. S. Dept. Agr., 1899; Bul. 19, n. s., Div. Ent., pp. 20–28, 189

Squash-vine Borer (*Melittia satyriniformis* Hbn. [*Ægeria cucurbitæ and Melittia ceto*]). CHITTENDEN—Bul. 19, n. s., Div. Ent. U. S. Dept. Agr., pp. 34–40, 1899; Circ. 38, Div. Ent. U. S. Dept. Agr., 1899.

Pickle Worm (*Diaphania nitidalis* Cram. [*Eudioptis* and *Margaronia nitidalis*]). CHITTENDEN—Bul. 19, n. s., Div. Ent. U. S. Dept Agr., pp. 40–42, 1899; LINTNER—11th Rept. N. Y. St. Ent., pp. 126–133, 1896; QUAINTANCE—Bul. 54, Ga. Agr. Exp. Sta., pp. 73–91, figs., 1901 (including bibliography).

Melon Caterpillar (*Diaphania hyalinata* Linn.). CHITTENDEN—Bul. 19, n. s., Div. Ent. U. S. Dept. Agr., pp. 42–44, 1899; QUAINTANCE—Bul. 45, Ga. Agr. Exp. Sta., pp. 42–45, 1899.

CELERY, CARROT, PARSLEY AND PARSNIP

Celery Looper (*Autographa simplex* Guen. [*Plusia simplex*]). CHITTENDEN—Bul. 33, n. s., Div. Ent. U. S. Dept. Agr., pp. 73, 74, 1902.

Greenhouse Leaf-tyer (*Phlyctænia ferrugalis* Hubn. [*P. rubigalis* Guen.]). CHITTENDEN—Bul. 27, n. s., Div. Ent. U. S. Dept. Agr., pp. 7–26, 1901 (including bibliography).

Celery Caterpillar (*Papilio polyxenes* Fab. [*P. asterias*]). DAVIS—Bul. 102, Mich. Agr. Exp. Sta., pp. 21–24, 1893. (For monographic treatment see works of Scudder and Edwards on Butterflies.)

Carrot Rust-fly (*Psila rosæ* Fab.). CHITTENDEN—Bul. 33, n. s., Div. Ent. U. S. Dept. Agr., pp. 26–32, 1902.

Carrot Beetle (*Ligyrus gibbosus* DeG.). L. c., U. S. Dept. Agr., pp. 32–37, 1902.

Parsnip Webworm (*Depressaria heracliana* DeG.). RILEY—Insect Life, v. 1., pp. 94–98, 1888.

Parsnip Leaf-miner (*Acidia fratria* Loew. [*Trypeta fratria*]). COQUILLETT—Insect Life, v. VII., pp. 383, 384.

Little Negro Bug (*Corimelæna pulicaria* Germ.). DAVIS—Bul. 102, Mich. Agr. Exp. Sta., pp. 13–18, 1893.

SWEET CORN

General. FORBES—23rd Rept. St. Ent. Ills., pp. 1–273, figs., pls., 1905 (includes bibliography).

Seed-corn Maggot (*Pegomya fusciceps* Zett. [*Phorbia fusciceps, Anthomyia zeæ,* etc.]). CHITTENDEN—Bul. 33, n. s., Div. Ent. U. S. Dept. Agr., pp. 84–92, 1902; Circ. 63, Bu. Ent. U. S. Dept. Agr., pp. 1–3, fig., 1906.

Corn Root-worms (*Diabrotica longicornis* Say. [*D. 12-punctata* Ol.]). CHITTENDEN—Circ. 59, Bu. Ent. U. S. Dept. Agr., 8 pp., 3 figs., 1905.

Corn Bill-bugs. General. FORBES—16th Rept. St. Ent., Ills., pp. 58–74, 1890; Bul. 79, Ills., Agr. Exp. Sta., 27 pp., 1902.

Southern Corn Bill-bug (*Sphenophorus maidis* Chttn. [*Sph. robustus* Authors]). FORBES—L. c.; RILEY—Rept. Comm. Agr. 1881–2, pp. 138–142, 1883.

Clay-colored Bill-bug (*Sphenophorus æqualis* Linn.).—Treated as *Sph. ochreus* Lec., by FORBES, l. c.

Northern Corn Bill-bug (*Sphenophorus zeæ* Walsh).—Generally called by authors *S. sculptilis* Uhl., l. c.

Larger Corn Stalk-borer (*Diatræa saccharalis* Zell.). HOWARD—Circ. 16, Div. Ent. U. S. Dept. Agr., pp. 1–3, 3 figs., 1896.

Smaller Corn Stalk-borer (*Elasmopalpus lignosellus* Zell.). CHITTENDEN—Bul. 23, n. s., Div. Ent., U. S. Dept. Agr., pp. 17–22, 1900.

Corn-ear Worm; Cotton Bollworm (*Heliothis obsoleta* Fab. [*armiger* Hbn.]). QUAINTANCE—Farmers' Bul. 191, 1904; QUAINTANCE and BRUES—Bul. 50, Bu. Ent. U. S. Dept. Agr., pp. 1–155, figs. and pls., 1905 (includes bibliography).

POTATO, EGGPLANT AND RELATED PLANTS

General. RILEY—Potato Pests, Orange Judd Co., N. Y., pp. 1–108, figs. 48, 1876.

Colorado Potato Beetle (*Leptinotarsa decemlineata* Say. [*Doryphora 10-lineata*]). CHITTENDEN—Circ. 87, Bu. Ent. U. S. Dept. Agr., 15 pp., 6 figs., 1907.

Potato-tuber Worm or Tobacco Split-worm (*Phthorimæa operculella* Zell. [*Lita* and *Gelechia solanella*]). RILEY and HOWARD—Insect Life, v. IV., pp. 239–242, 1892; HOWARD—Farmers' Bul. 120, U. S. Dept. Agr., pp. 19–22, 1900; CLARKE—Bul. 135, Cal. Agr. Exp. Sta., 29 pp., 7 figs., 1901.

Potato-stalk Weevil (*Trichobaris trinotata* Say.). CHITTENDEN—Bul. 33, n. s., Div. Ent., U. S. Dept. Agr., pp. 9–19, 1902.

Tobacco Flea-beetle (*Epitrix parvula* Fab.) CHITTENDEN—Bul. 19, n. s., Div. Ent., U. S. Dept. Agr., pp. 85–87, 1899.

Potato or Cucumber Flea-beetle (*Epitrix cucumeris* Harr.). CHITTENDEN—Bul. 19, n. s., Div. Ent., U. S. Dept. Agr., pp. 89, 90, 1899.

TOMATO

Northern Tobacco Worm or Tomato Worm (*Phlegethontius quinquemaculata* Haw. [*Protoparce celeus*]). HOWARD—Farmers' Bul. 120, U. S. Dept. Agr., pp. 10–14, 1900.

Southern Tobacco Worm or Hornblower (*Phlegethontius sexta* Joh. [*Protoparce carolina*]). HOWARD—L. c.; ALWOOD, Bul. 17, n .s., Div. Ent. U. S. Dept. Agr., pp. 72–74, 1898.

Common Stalk-borer (*Papaipema nitela* Guen. [*Gortyna nitela*]). SMITH—Rept. Ent. Dept. N. J. Agr. Coll. Exp. Sta. f. 1905 (1906), pp. 584–587.

Greenhouse White Fly (*Aleyrodes vaporariorum* Westw.). MORRILL—Circ. 57, Bu. Ent. U. S. Dept. Agr., pp. 1–9, fig., 1905.

SWEET POTATO

General. SANDERSON—Sweet Potato Insects, Bul. 59, Md. Agr. Exp. Sta., 1900.

Sweet-potato Root-borer (*Cylas formicarius* Fab.). CONRADI—Bul. 93, Texas Agr. Exp. Sta., pp. 3–16, figs., 1907.

Larger Sweet-potato Sawfly (*Schizocerus privatus* Nort.). MARLATT—Insect Life v. V., pp. 24–27, fig. 6, 1892.

Sweet-potato Flea-beetle (*Chætocnema confinis* Cr.). SMITH—13th Rept. N. J. Agr. Exp. Sta., pp. 472–475, 1892.

Mottled Tortoise Beetle (*Coptocycla signifera* Hbst. [*C. guttata*]). SANDERSON—L. c.

Golden Tortoise Beetle (*Coptocycla bicolor* Fab. [*C. aurichalcea*]). —L. c.

ONION

Imported Onion Maggot (*Pegomya ceptorum* Meade [*Anthomyia* and *Phorbia ceparum* Bouché]). CHITTENDEN—Circ. 63. Bu. Ent. U. S. Dept. Agr., pp. 6, 7, 1906; SMITH and DICKERSON—Bul. 200, N. J. Agr. Exp. Sta., 27 pp., 13 figs., 1907.

Onion Thrips (*Thrips tabaci* Lind.). PERGANDE—Insect Life, v. VII., pp. 392–395.

RHUBARB

Rhubarb Curculio (*Lixus concavus* Say.). CHITTENDEN—Bul. 23, n. s., Div. Ent. U. S. Dept. Agr., pp. 61–69, 1900.

INSECTICIDES

1902. HINDS, W. E.—Carbon Bisulphid as an Insecticide. Farmers' Bul. 145, 28 pp.

1902–04. HAYWOOD, J. K.—Reports on Analyses of Insecticides. Buls. 68, 76 and 82, Bu. Chem., U. S. Dept. of Agr. and Farmers' Bul. 146, 16 pp.

1903. MARLATT, C. L.—Important Insecticides. Farmers' Bul. 127, U. S. Dept. Agr., 46 pp., 6 figs.

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